
Appendix D
Ecosystem Restoration Evaluation Report

Draft for Discussion Purposes Only

Draft Ecosystem Restoration Evaluation Report
Chatfield Reservoir Reallocation Study

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Table of Contents

Section 1 - Introduction

Study Objectives

Study Sponsors

Section 2 - Approach and Methodology

Overview

Methodology

Hydrology

Quantitative Biology

Section 3 - Results

Hydrology

Biology

Section 4 - Key Observations

Attachments

A - Habitat Suitability Data for Species of Interest

B - Cross Section Flow and Wetted Perimeter Analysis

C- Habitat Flow Relationships

Section 1

Introduction

The South Platte River corridor provides important natural resources and associated aesthetic and recreational opportunities to millions of people living along its banks in the Colorado Front Range. The river serves to transport water from the mountains down to the thirsty municipal and agricultural water users lining the foothills, stretching out into the state's eastern plains. Along the way, the river's natural ecosystem contains a great diversity of flora and fauna that rely upon the river for food and habitat. The river also provides for numerous, important recreational opportunities, which help to support the local economy.

On its route from the mountains to the eastern plains, the South Platte River passes through the Denver metropolitan area. The river is challenged to maintain its ecological and environmental functions as the urban setting increasingly encroaches on its banks and impacts the water's flow and quality. Upstream reservoirs, channelization, wastewater discharges, and diversions all influence the aquatic habitat quality and riparian corridor. In addition, river flows are at times not sustainable such that in some locations the river is dry and/or discontinuous during various times of the year, especially during the winter months.

A once-in-a-generation opportunity to improve flows below the Chatfield Reservoir is within reach – which involves the retiming of South Platte River runoff by reallocating storage in Chatfield Reservoir. In 1986, the federal government authorized the US Army Corps of Engineers (USACE) to evaluate the:

“...feasibility and economic justification to reassign a portion of of the storage space in the Chatfield Lake project to joint flood control-conservation purposes, including storage for municipal and industrial water supply, agricultural, and recreation and fishery habitat protection and enhancement.”
(excerpt from Section 808, Water Resources Development Act (WRDA) 1986)

Therefore, through appropriate planning and implementation, water may be placed in the South Platte River at times when it is most needed to help enhance and protect fishery (and other water dependent species) habitat, in conjunction with and without compromising other programmed water uses (e.g., municipal and industrial water supply, etc.).

Study Objectives

The study described and discussed in this white paper was developed to evaluate the opportunities to protect and enhance fishery habitat below Chatfield Reservoir through the management of future water releases from the reallocated storage conservation pool, which for purposes of this white paper was assumed to be 20,600

acre-feet extending for 12 feet above the current Denver Water 27,428 acre-foot pool. Note that improving the fishery habitat is also expected to improve the general river ecosystem and recreational opportunities within and adjacent to the river.

Note that this study, which is based on analyses conducted in the third and fourth quarter 2006, is considered to be limited to a preliminary evaluation of options associated with the management of future reservoir releases from the reallocated storage managed for water supply, recreation and fishery habitat protection and enhancement. Additional analyses are currently being conducted to expand the understanding of the benefits of managed releases on the downstream fishery and aquatic habitat. The results of these additional analyses will be made available in a separate document to be produced before the end of this calendar year.

Study Sponsors

The work presented in this white paper was performed as a result of funding provided by the downstream and selected upstream water users associated with the Chatfield Reallocation project including: City of Aurora, the City of Brighton, Castle Pines Metro District, Castle Pines North Metro District, Central Colorado Water Conservancy District, and Western Mutual Ditch Company; as well as the instream users: City and County of Denver, Denver Water (DW), the Greenway Foundation, the City of Littleton, and the Metropolitan Wastewater Reclamation District (Metro).

Section 2 Approach and Methodologies

Overview

Technical analyses were performed to characterize the benefit of having retimed flow in the South Platte below Chatfield Reservoir associated with the reallocation of flood storage in Chatfield. Specifically, the analyses involve coupling hydrologic and hydraulic calculations with characteristic habitat suitability information to estimate changes to habitat quantity for selected fish – both juvenile and adult – based on various future river flow regimes for conditions with and without the Chatfield storage reallocation.

The study area was established based on the location of available river cross-sectional information, river gages, and the diversions of downstream water users. Figure 1 presents the overall study area.

The specific flow regimes that were evaluated during this study include two sets of baseline hydrologic conditions – current configuration of the hydrologic setting (aka 2005 conditions) and the hydrologic setting that is expected to exist at build-out of the Chatfield Reservoir system (aka 2050). These two baseline conditions were developed assuming that reallocation of Chatfield storage does not occur now or into the future.

Using these two baseline conditions, two scenarios were developed to simulate future releases from Chatfield assuming that reallocation will occur – one, based on water user defined releases from both upstream and downstream water users; and one, based on water user defined releases for the upstream water users only. For this second scenario, it was assumed that the downstream water users would release water only at times when flows at locations downstream of Chatfield fell below 10 cubic feet per second (cfs). The second scenario allowed for reservoir releases whenever downstream flows were less than 10 cfs at any time, as long as water remained in the reallocated storage pool. This second scenario represents a more ecosystem restoration (ER) friendly future water release scenario, and therefore it is used to provide initial insight into how alternative water release schemes could improve the downstream fishery habitat without substantially compromising downstream water supply needs.

Physical Habitat Simulation System (PHABSIM) analyses were performed to combine channel hydraulics with habitat use information provided by various sources and approved for use in this study by the Colorado Department of Wildlife (DOW) to predict habitat quantity for a range of flows. Using the above alternative flow scenarios, the habitat discharge relationships were combined with flow to produce a quantification of habitat over time.

Specific assumptions and methodologies used for each of the modeling efforts are discussed in the sections below.

Methodology

Hydrology – DW provided information on baseline hydrology in the South Platte River, as well as information on the frequency and duration of future releases from Chatfield Reservoir to the South Platte based on criteria developed by the Technical Working Group in 2006. Specifically, DW used output data from its proprietary PACSM model in a spreadsheet model (described in more detail below) to estimate daily flows at six locations in the river downstream of Chatfield:

- Chatfield Outflow
- Englewood Gage at Union Boulevard
- Denver Gage at 19th Street
- Below Burlington Canal above 58th Street
- Henderson Gage at 120th Street
- Fort Lupton Gage

PACSM is a complex river system model developed and used to determine DW's water supply in the South Platte and Colorado River systems. The model incorporates the water systems and water rights of DW and others at over 450 nodes.

PACSM has been reviewed and accepted for use as a hydrologic model by numerous experts. It has been reviewed by the USACE for its use in the Moffat EIS. It has also been reviewed by FERC for two re-licensing efforts. Numerous local water providers and consultants have also reviewed it in conjunction with various east and west slope water studies.

Under the two development conditions used for this study – 2005 and 2050 – daily hydrology for the period from 1947 through 1991 was input to PACSM to simulate expected flows at the six stations indicated above (as shown on Figure 1 and Figures 3 through 8) for the situation where the pool elevation does not rise above an elevation of 5,432 feet, which is the top of DW's 27,428 acre-foot pool. Operating Chatfield in this manner was considered the “baseline” condition against which the impact of future releases from the reallocated storage on downstream fishery habitat was compared.

To simulate downstream releases from the reallocated storage pool, which exists above DW's pool extending from 5,432 to 5,444 feet, PACSM output data was used in a spreadsheet model, which tracked free river inflows, other inflows, upstream water user demand, evaporation and either downstream water user demand or

downstream water user releases to maintain 10 cfs in selected reaches. To this end, three simulated flows were developed at each of the six downstream stations for two different baseline conditions. These alternative flow scenarios are summarized in Table 1. A schematic of the spreadsheet conceptual model is provided in Figure 2.

Figure 2

DW's current Chatfield pool operation was represented by storage data from the PACSM model. The reallocation pool was simulated on a daily time step above Denver Water's pool. For reservoir inflows, the spreadsheet model used inflows available from a new (junior) water storage rights and inflows from other upstream sources to fill the reallocation pool.

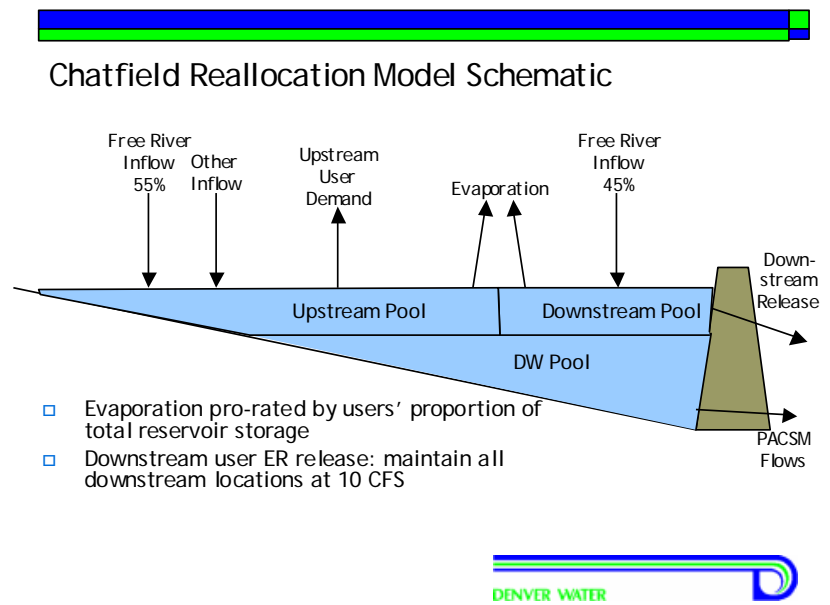


Table 1 - Summary of Hydrologic Simulations

PACSM Run	Spreadsheet Run	Reservoir Outflow Conditions
Baseline - 2005 Conditions	None	Existing
	Reallocation without ER	Upstream and Downstream User Specified
	Reallocation with ER	Upstream User Specified, Downstream based on river need for 10 cfs
Baseline - 2050 Conditions	None	Existing
	Reallocation without ER	Upstream and Downstream User Specified
	Reallocation with ER	Upstream User Specified, Downstream based on river need for 10 cfs

The spreadsheet model also calculated the releases from the reallocation pool to the South Platte River based on the water available in the reallocation pool. To this point, the spreadsheet model calculated releases based on the alternative downstream flow conditions - either those specifications defined in the EIS by the downstream users or those defined by minimum flow requirements (i.e., the 10 cfs preliminary ER release). The resultant changes in outflows from the baseline conditions were added to, or subtracted from, downstream flows calculated by PACSM at the six downstream gage locations. Upstream users' outflows were withdrawn directly from Chatfield or its outlet works and did not affect downstream flows, but were nonetheless tracked in the model.

Evaporation from the Chatfield reallocation pool was assumed to equal a pro-rated share of the calculated evaporation based on the water user's portion of the total reservoir storage. The spreadsheet model did not simulate individual water user pools or inflows or outflows, but rather lumped upstream users together and downstream users together. The spreadsheet model did not account for unused inflow, nor did it include carriage losses on water released to the river.

Quantitative Biology - The quantitative methodology that was used, as approved by the Technical Working Group, was based upon the linkage of the hydrology with PHABSIM which characterizes changes in stream flow velocity, depth, wetted perimeter, as well as other physical habitat information, for purposes of estimating habitat area for each of the alternative flow scenarios for the South Platte from Chatfield downstream to below Fort Lupton.

PHABSIM was developed using the following data:

Cross-Sections and transects and other related hydraulic data

- The City of Littleton provided 6 cross sections located in South Platte Park to characterize the reach from Chatfield downstream to Englewood;
- The DW provided 11 cross-sections based on from past Two-Forks efforts for locations near Union Street, Evans and Franklin Street; and
- Metro provided 5 cross sections from Burlington Ditch downstream to Fort Lupton.

Figures 3 through 8 present the location of each of these reaches of interest and the associated cross sectional information relative to the hydrologic stations.

Location of pools, riffles and glides

The sections provided by Littleton, DW and Metro include characteristic riffles and run within each of the six reaches. Specific information regarding the size and location of the river bed features was developed based on past modeling efforts and recent and past field reconnaissance by Chadwick Ecological Consultants and Miller Ecological Consultants for South Platte CURE, Metro, and other studies in the river.

Habitat suitability data

Habitat suitability data, which was used to develop the flow versus habitat relationships, is contained in Attachment A. These data were based upon DOW approved and/or reviewed studies as follows:

- Brown and rainbow trout, juvenile and adult - CDOW South Platte River
- Channel catfish, adult - Peters et al. 1989 - Platte River
- Channel catfish, juvenile - Chadwick Platte River

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- Common carp, adult - Chadwick Platte River
- Sand shiner, adult - Chadwick Platte River
- Longnose dace, adult - USFWS HSI criteria
- White sucker, adult and juvenile - USFWS HSI criteria

Some of these data may need some “tweaking” in the future depending on the use of the habitat assessment; however DOW is comfortable using this combination of literature for this application since they have been successfully applied to the South Platte in the past. Future adjustments may, nonetheless, be needed to account for the unique combination of warm and cool water environments in the South Platte River below Chatfield Reservoir.

PHABSIM and habitat time series analyses were used to develop habitat unit duration and exceedance curves for the alternative flow scenario impacts on fisheries in the South Platte River. Specifically, the biological modeling proceeded as follows:

- Depth, wetted perimeter, and velocity were estimated over the range of expected flows included within each alternative to characterize habitat within each cross section for each species and fish type (i.e., juvenile and adult);
- Habitat versus flow relationships were developed for each reach and fish type and species over the range of expected flows using the habitat suitability data;
- Simulated daily flows for each alternative hydrologic condition developed using modeling data for the period from 1947 to 1991 were converted to habitat area in each reach based on the habitat versus flow relationships developed in the last step; and
- Habitat area was evaluated against return period (i.e., habitat vs. time) across the entire reach from Chatfield to Fort Lupton to characterize the benefits of the proposed storage reallocation, and to determine whether or not “ER Releases” would provide additional benefits to the fisheries above and beyond those that are expected to occur when and if the reallocation occurs.

PHABSIM results may have to be amended in the future to allow for a broader analysis to demonstrate other benefits such as those related to migratory birds and water fowl; however, the bird and duck habitat suitability data are not as robust as the fish data, nor is there a process under the current federal authorization for these data to be used to evaluate future environmental conditions along the Platte.

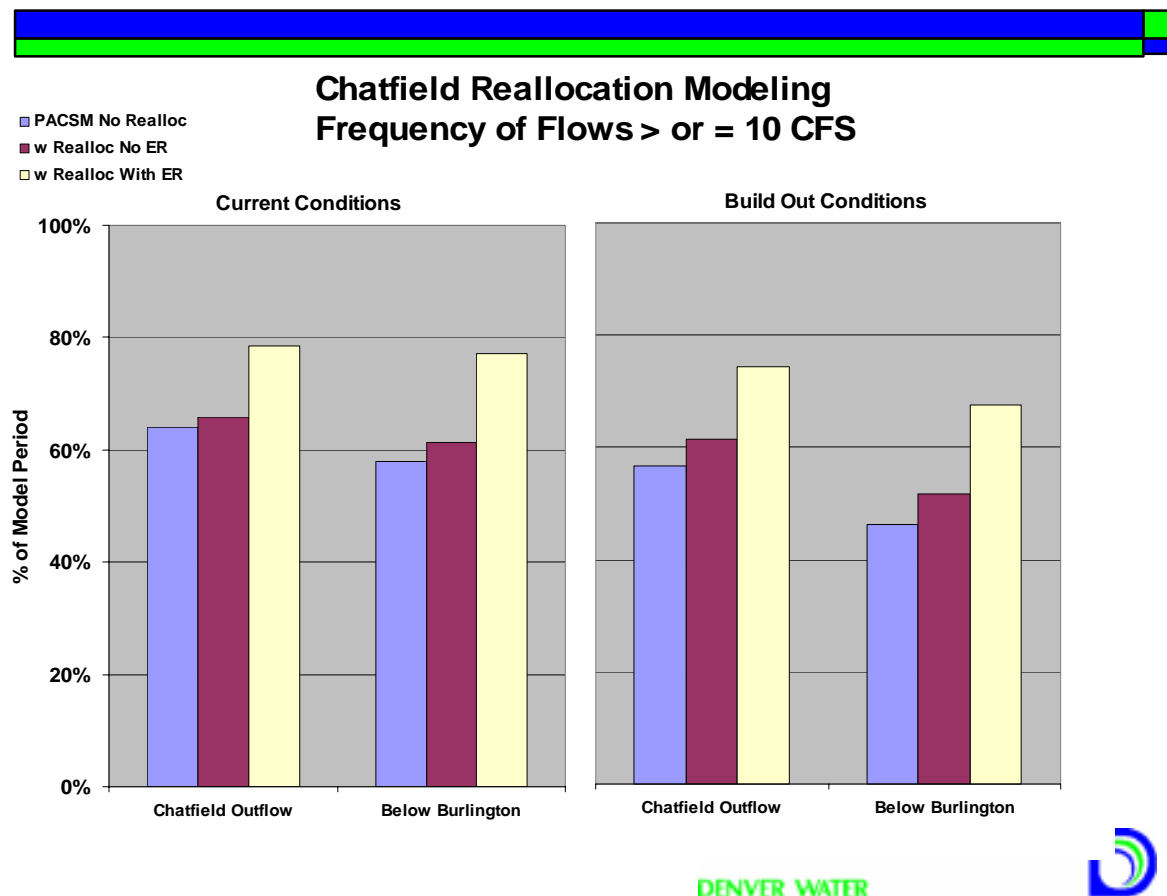
Section 3 Results

Hydrology

The coupled PACSM and spreadsheet model was able to simulate the various different reservoir release scenarios for Chatfield both with and without the 20,600 acre-feet of reallocated flood storage for both current conditions (2005) and build-out conditions (2050). The results of the simulations indicate, not surprisingly, that capturing South Platte River runoff using the reallocated storage to retime peak flows for release to the downstream users during non-peak periods increases flows during those times when the river at selected places below Chatfield would otherwise be dry or at low flow.

Two locations where the river has historically been observed to have flows below 10 cfs nearly every year includes below the Chatfield Reservoir outfall and below the Burlington Ditch Headgate. Figure 9 presents a graphic representation of how the reallocation will help to decrease the number of days that flow in these two areas drops below 10 cfs.

Figure 9



Based on these results, it can be seen that flows beneath Chatfield are greater than 10 cfs about 60% of the time under current conditions without the reallocation, and will drop to about 55% of the under build-out conditions. With the proposed storage reallocation, the downstream water user specified releases (i.e., with no ER) have incremental benefits to the stream flow below Chatfield. Specifically, the reallocation with the downstream water users EIS specified releases increase by 3 to 12 percent the number of days that have flows below Chatfield and/or below Burlington Ditch at 10 cfs or greater, based on simulations using the 1947 to 1991 hydrology. The greatest incremental benefits related to the flow analyses appear to occur below Burlington Ditch and under build-out conditions; however incremental benefits are shown for both set of watershed conditions (i.e., current and build-out) and at both key locations (i.e., at the Chatfield Outflow and below the Burlington Ditch) with the EIS specified releases.

Another important finding is that there appears to be alternative release patterns from the reallocated Chatfield Reservoir storage that may substantially increase the benefits of future downstream releases on the fishery habitat. The “Reallocation with ER” results provided in Figure 9 illustrate this point. Specifically, the reallocation with ER, which revises the downstream water user releases to address fall and wintertime low flows increases by 23 to 46 percent the number of days that have flows below Chatfield and/or below Burlington Ditch of 10 cfs or greater, based on simulations using the 1947 to 1991 hydrology.

The ER managed flow regime needs to be further characterized with respect to improved and enhanced fish habitat and stream biology, which is a component of the modeling currently being developed and documented; however it is clear that wintertime flow releases can dramatically improve the number of days that the river has greater than 10 cfs flowing in its banks.

Biology

Habitat versus flow relations were developed after the range of flows were simulated within each of the cross sections as presented in Attachment B (note that the actual range of flows included in the cross sections was a broader range than shown in Attachment B). The habitat flow relationships were developed for each of the species of interest by physical reach as indicated in the Table 2.

The resulting habitat flow relationships for each of the physical reaches is presented in Attachment C.

Noteworthy is that for the trout and channel catfish, the flow regime that produces the most habitat is different for juveniles and adults. In general, adults can live in deeper and faster moving water than the juveniles. Also, many of the fish species were found to have a habitat area that suffers if flows become too large. For non-

trout species, a river flow of greater than 100 to 200 cfs was found to have a detrimental impact on habitat area. This was also true for the sand shiner, longnose dace, white sucker and common carp.

Table 2 – Summary of Habitat to Flow Relationships

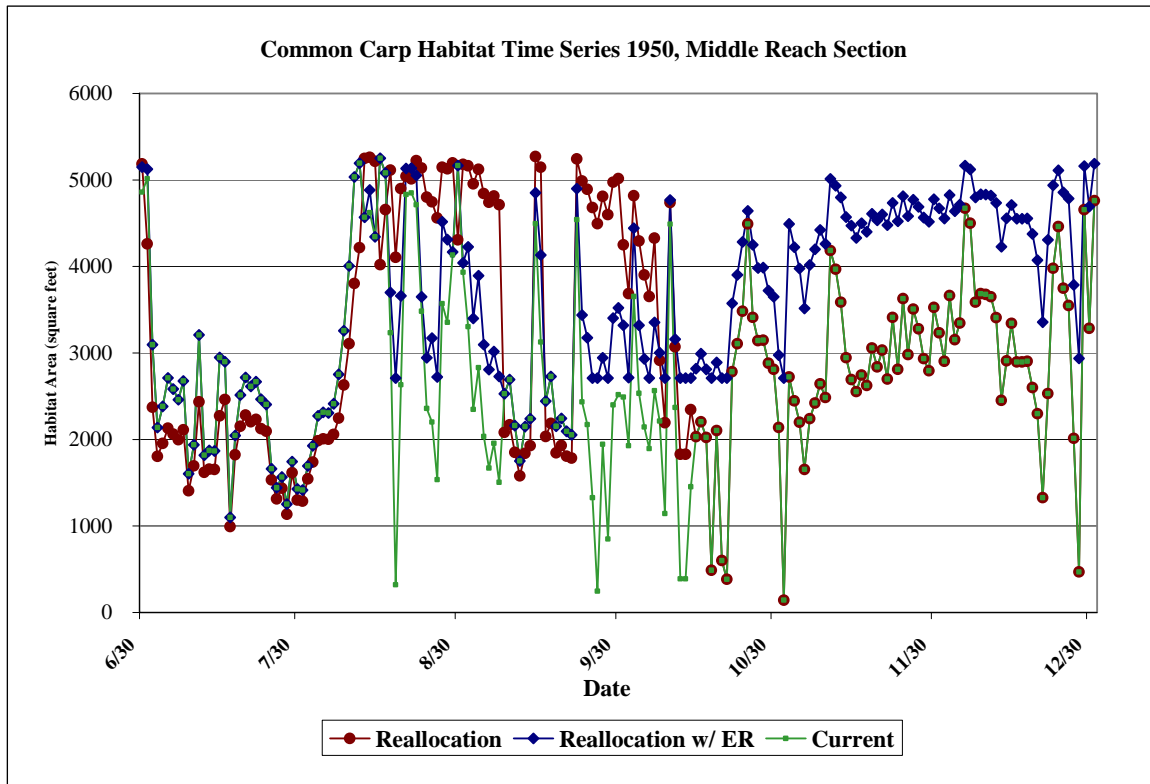
Physical Reach	Reach Numbers	Species
Southern	1, 2	Rainbow trout (juvenile, adult), brown trout (juvenile, adult), channel catfish (juvenile, adult), sand shiner (adult), longnose dace (adult), white sucker (juvenile, adult), common carp (adult)
Middle	3, 4	channel catfish (juvenile, adult), sand shiner (adult), longnose dace (adult), white sucker (juvenile, adult), common carp (adult)
Northeastern	5, 6	channel catfish (juvenile, adult), sand shiner (adult), longnose dace (adult), white sucker (juvenile, adult), common carp (adult)

Another important observation was that for trout and channel catfish juveniles and the smaller adult fish (e.g., sand shiner, longnose dace, and white sucker), the biggest jump in habitat area occurs at the lowest flows, especially for flows below 20 to 40 cfs. This same observation held true for common carp, as well. These observations may indicate that protection of low flows with future Chatfield releases may provide substantial benefit to the aquatic fisheries.

The habitat flow relationships were used to convert the predicted stream flows to habitat area over time. An example “hydrograph” of the converted stream flow to habitat area for one of the middle reach sections in 1950 (for the period from June to December) is presented in Figure 10 to illustrate the analysis methodology. This figure illustrates the relative magnitude and timing of the habitat benefits based on the increased flows that occur with each alternative flow scenario. For example, habitat area increases are observed in September and early October when reallocation occurs with the downstream water users EIS releases when compared to the current condition without reallocation. The estimated increases include as much as a doubling of habitat area for selected days, or more; and the benefits are seen to last for 5 to 6 weeks.

The increased habitat area created by the reallocation ER releases on the other hand, occur throughout September, October, November and December, since the release rate is lower under this flow scenario, and it is timed to benefit the fall and winter flow period.

Figure 10



Once the habitat area had been estimated over time for each species and sub-reach, total habitat area was calculated versus percent exceedances for each species over the entire study area to contrast and compare the incremental benefits of the potential future reallocated storage release scenarios on the fishery habitat. Table 3 presents the results of the total habitat area calculation for selected periods of exceedance for each of the species.

Table 3 – Summary of Total Habitat Area Impact versus Percent Exceedance (in percent)

	Channel Catfish				White Sucker				Carp		Sand Shiner		Longnose Dace		Brown Trout				Rainbow Trout			
	w/o ER		w/ ER		w/o ER		w/ ER		w/o ER	w/ ER	w/o ER	w/ ER	w/o ER	w/ ER	w/o ER		w/ ER		w/o ER		w/ ER	
%	J	A	J	A	J	A	J	A	A	A	A	A	A	A	J	A	J	A	J	A	J	A
80	.07	.03	3.6	11.	0.0	0.0	3.5	3.5	0.2	3.1	0.0	28.	0.8	6.0	0.0	0.0	126	163	0.0	0.0	153	117
70	0.5	4.4	0.2	13.	1.1	1.1	4.2	4.2	0.0	10.	2.0	25.	1.4	5.3	31.	40.	75.	97.	39.	29.	91.	70.
60	3.1	6.9	2.1	5.0	3.9	3.9	2.9	2.9	1.0	13.	2.2	7.6	3.3	2.9	28.	41.	22.	33.	26.	33.	21.	26.
50	0.9	1.1	.07	1.0	1.7	1.7	3.0	3.0	0.6	1.0	1.3	0.0	1.3	1.3	1.4	6.4	1.7	7.2	1.4	6.4	2.0	7.0

J – juvenile; A – adult

Figure 11 presents the total habitat area versus percent exceedance curves for four different fish to illustrate how the incremental impacts of retimed flow beneath Chatfield improve fish habitat.

Figure 11 and the contents of Table 3 illustrate that for all fish evaluated, which include all those fish that the DOW considers to be of state interest that are contained in the South Platte River, **habitat area can be improved with future reallocated storage releases** for some return period, typically during dry periods that occur from once in every two years (50%) to once in every five years (80%).

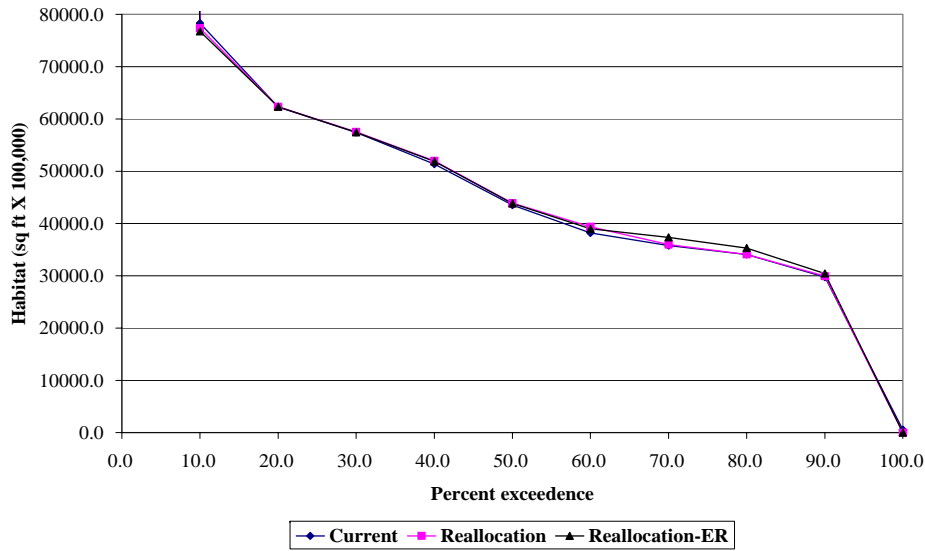
The greatest habitat improvement, based on percent increases in habitat area, was estimated to occur for the cold water species - brown and rainbow trout. For the return period of between once in every three years to once in every five years, habitat areas increased with future reallocated Chatfield storage releases by 21 to 153 percent for juveniles and 26 to 163 percent for adults, depending on species and return period. Adult trout habitat area appears to benefit most from retimed flows that occurred in the once out of every five years return period (i.e., 80 percent exceedance), whereas juvenile trout habitat area appears to benefit most from retimed flows in the once out of every three year return period. Juvenile habitat area does not appear to benefit from the retimed flows for the once in five year return period.

The biggest habitat area improvements for the cool and warm water species, based on percent increase in habitat area, typically occurred at the 60 or 70 percent exceedance for juveniles and the 80 percent exceedance for adults, in a manner consistent with the trout habitat; however the percent increase in habitat area for each of these species was estimated to be substantially less than that for trout, ranging from 0 to 28 percent. Nonetheless **there is a measurable increase in habitat area for all fish species due to the retimed releases from Chatfield.**

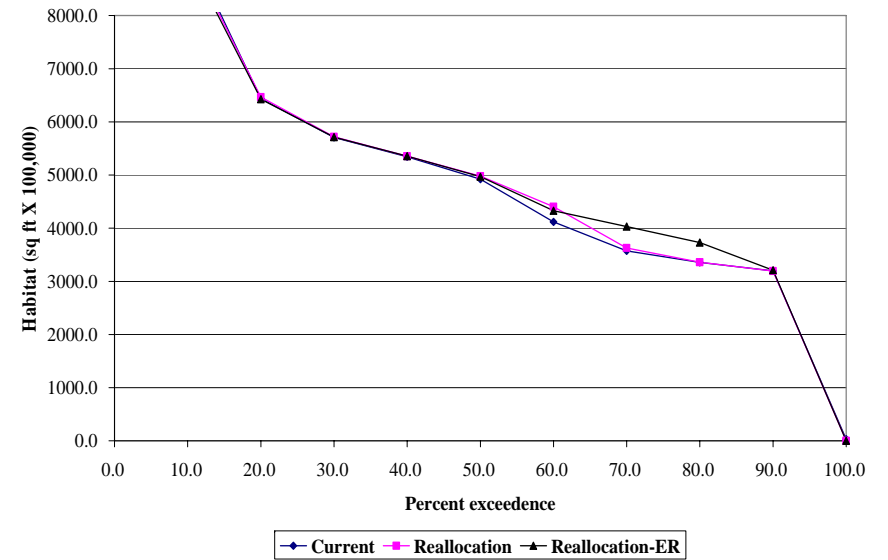
These preliminary findings also indicate that for most species of interest, the habitat area benefits related to the future reallocated storage releases can be improved by releasing low flows in the fall and winter months versus having releases during the summertime as currently indicated by the water user release scenarios contained in the EIS. There are some return periods for some species where the water user defined releases are as good if not better at enhancing fishery habitat below Chatfield than the "ER" releases (e.g., at 60% exceedance for white suckers), but these circumstances are the exception rather than the rule.

Figure 11

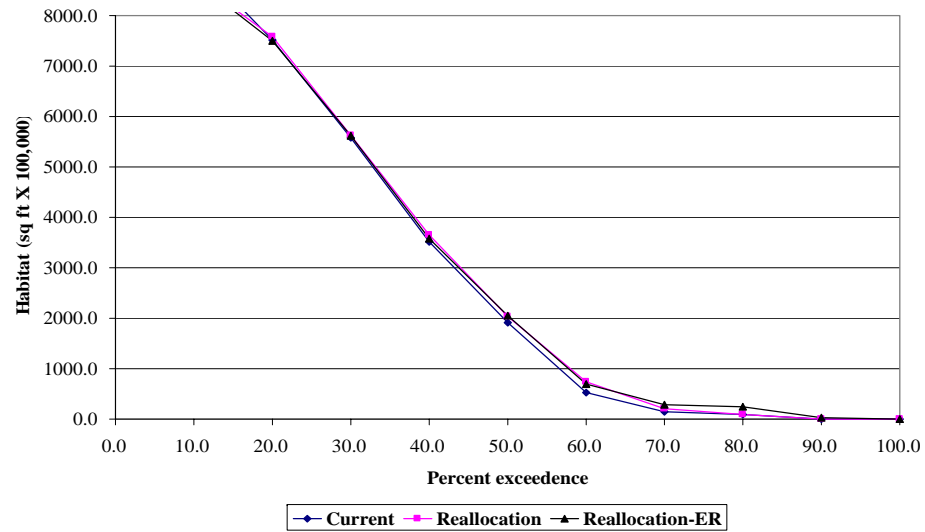
Total habitat exceedence, current conditions, channel catfish juvenile



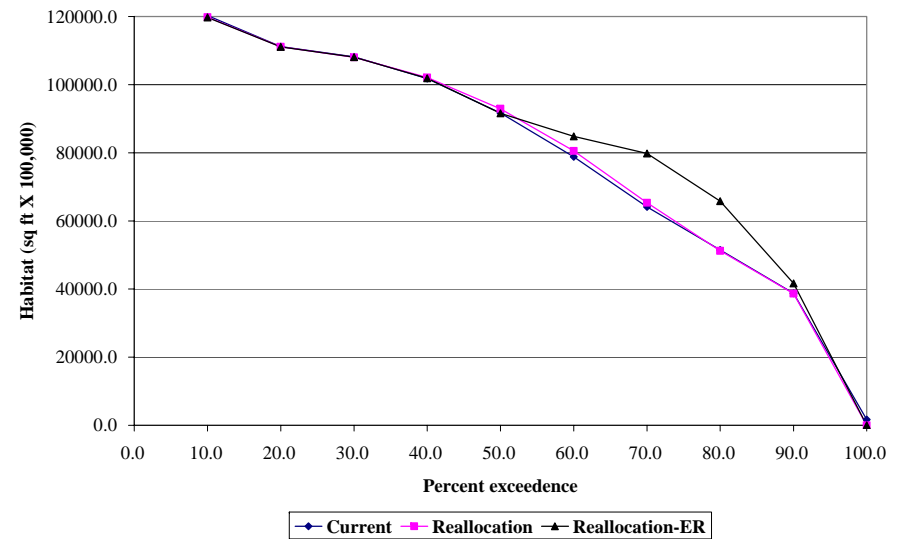
Total habitat exceedence, current conditions, channel catfish adult



Total habitat exceedence, current conditions, Brown trout adult



Total habitat exceedence, current conditions, sand shiner adult



Section 4 Key Observations

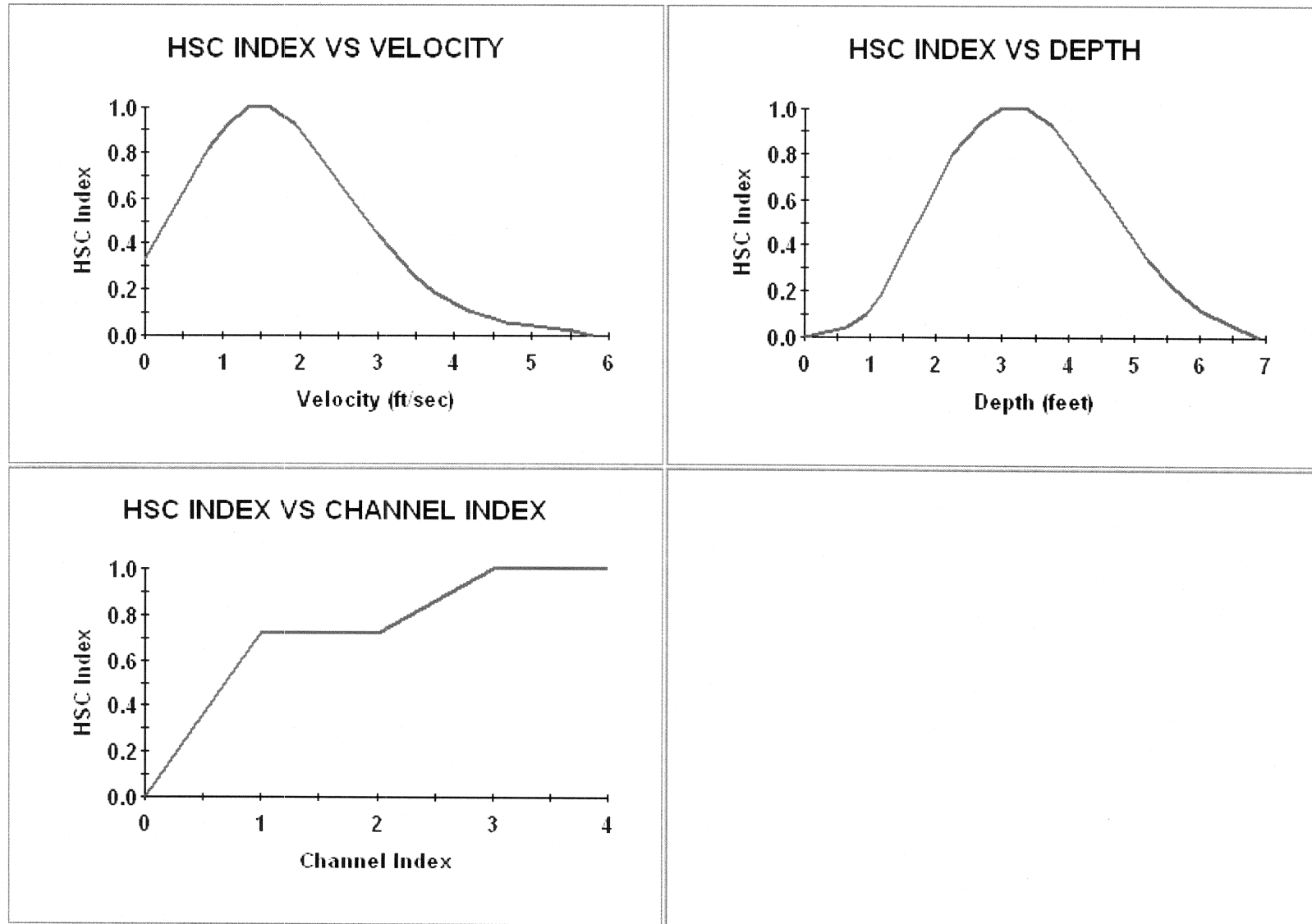
The key observations that were established based on the hydrologic and biological habitat modeling that was performed during this study are as follows:

- **For all fish evaluated**, which include all those fish that the DOW considers to be of state interest that are contained in the South Platte River, **habitat area can be improved with future reallocated storage releases** for some return period, typically during dry periods that occur from once in every two years (50%) to once in every five years (80%).
- **There is a measurable increase in habitat area for all fish species due to the retimed releases from Chatfield.**
- These preliminary findings also indicate that for most species of interest, the **habitat area benefits related to the future reallocated storage releases can be improved by releasing low flows in the fall and winter months** versus having releases during the summertime as currently indicated by the water user release scenarios contained in the EIS.
- Additional analyses are needed to better characterize the value and effect of alternative ER releases on the downstream fishery habitat.

Attachment A

Habitat Suitability Data for Species of Interest

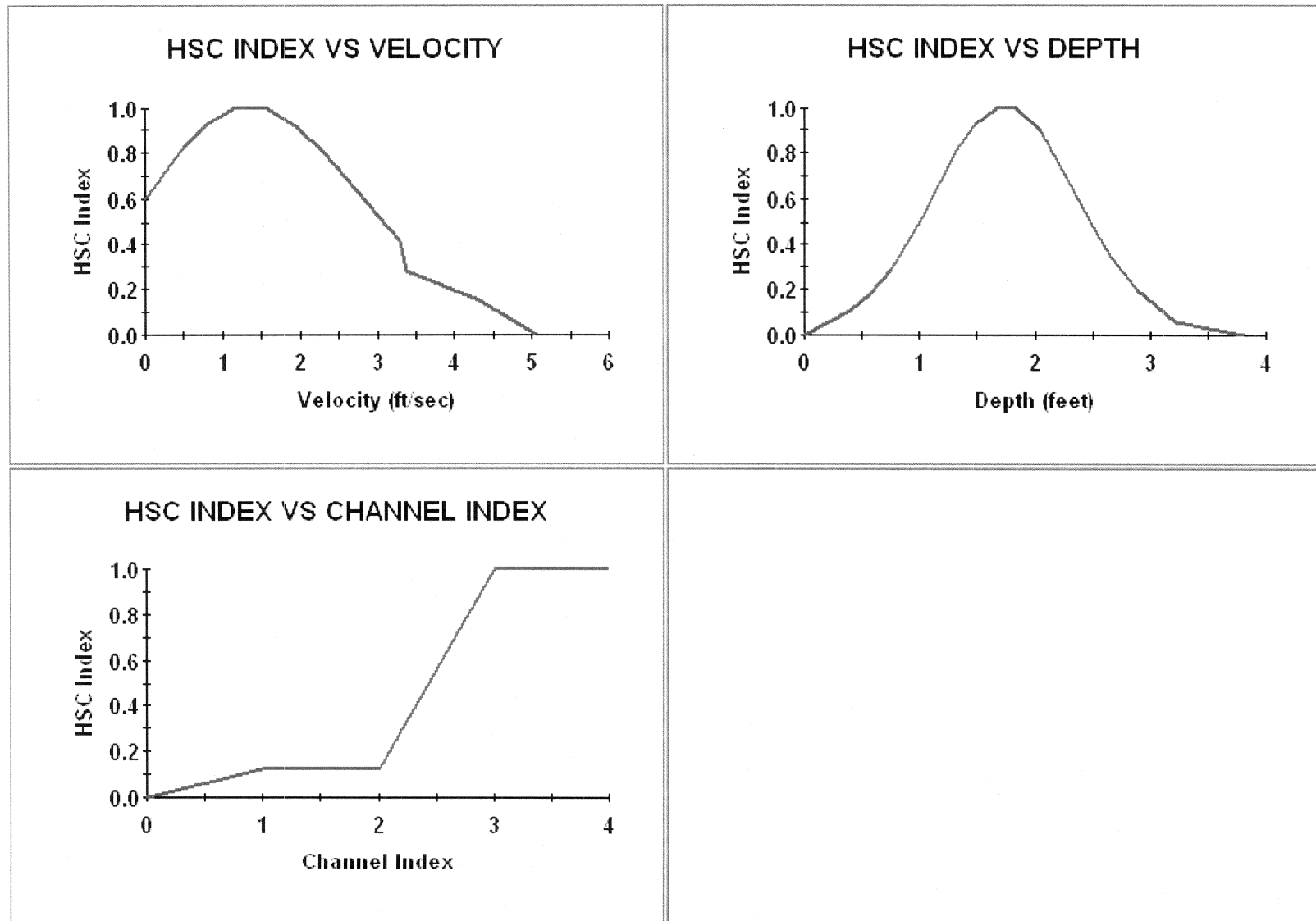
Brown Trout - Adult



November 17, 2006

Preliminary Results— Subject to
Revision

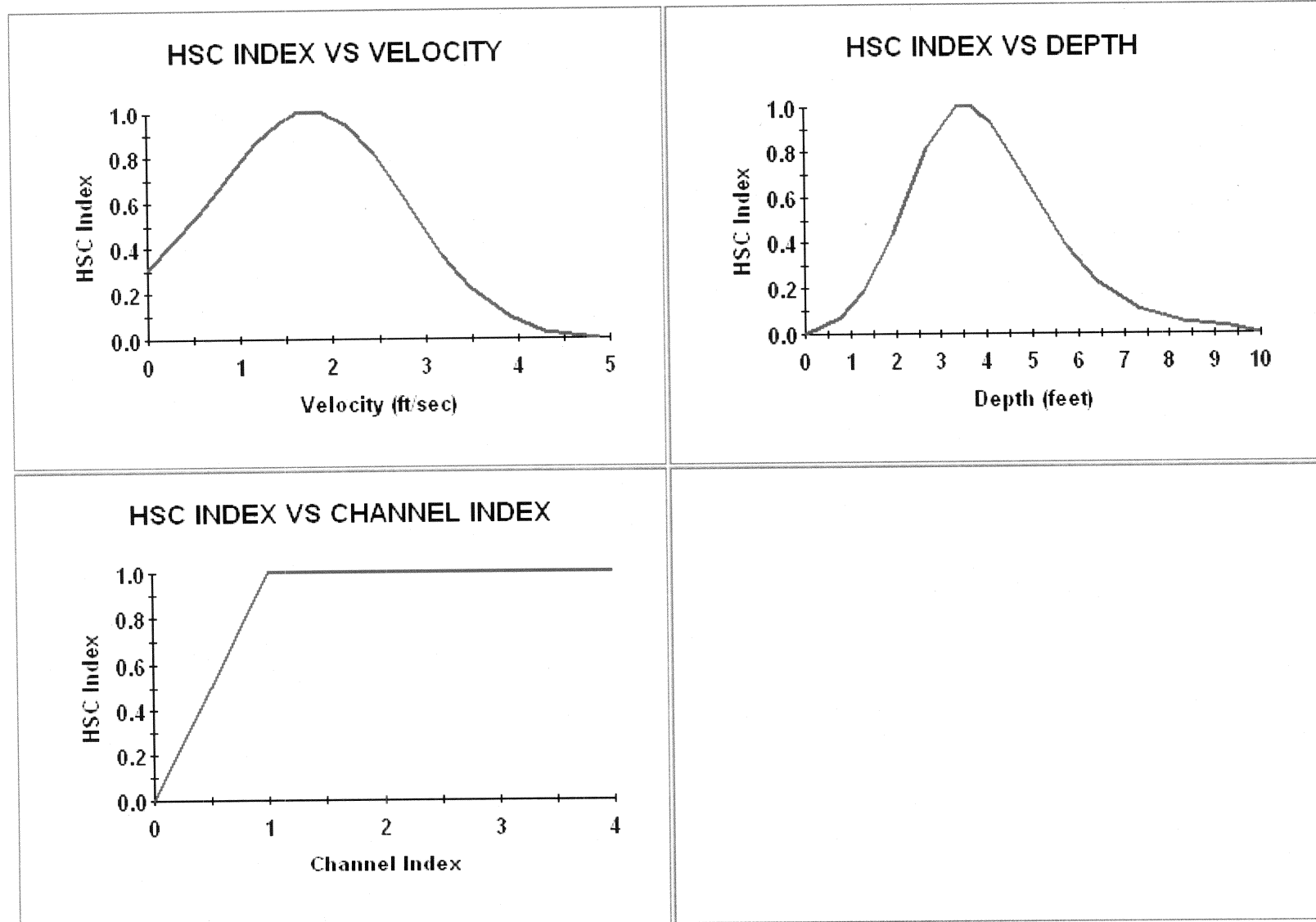
Brown Trout - Juvenile



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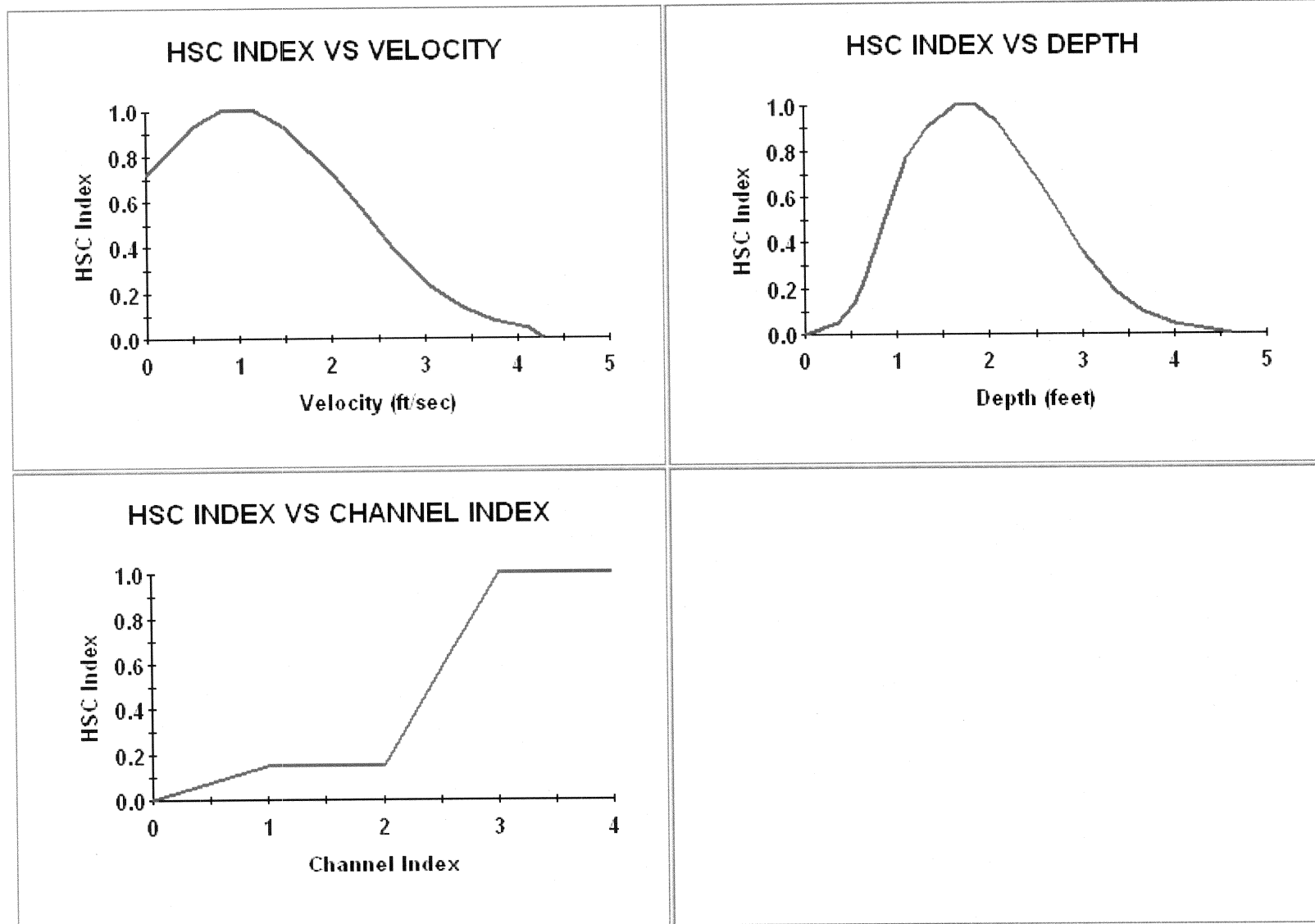
Rainbow Trout - Adult



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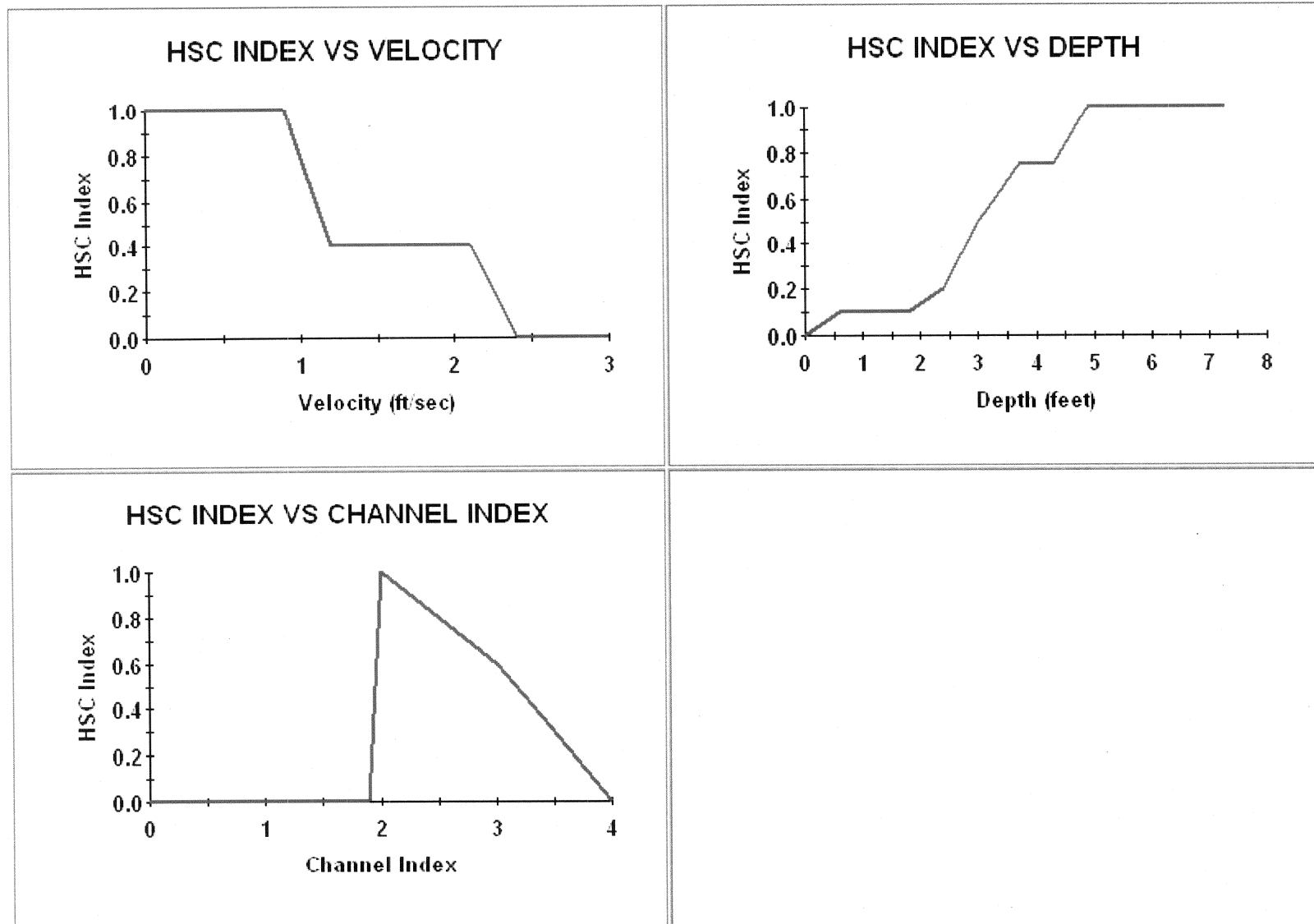
Rainbow Trout - Juvenile



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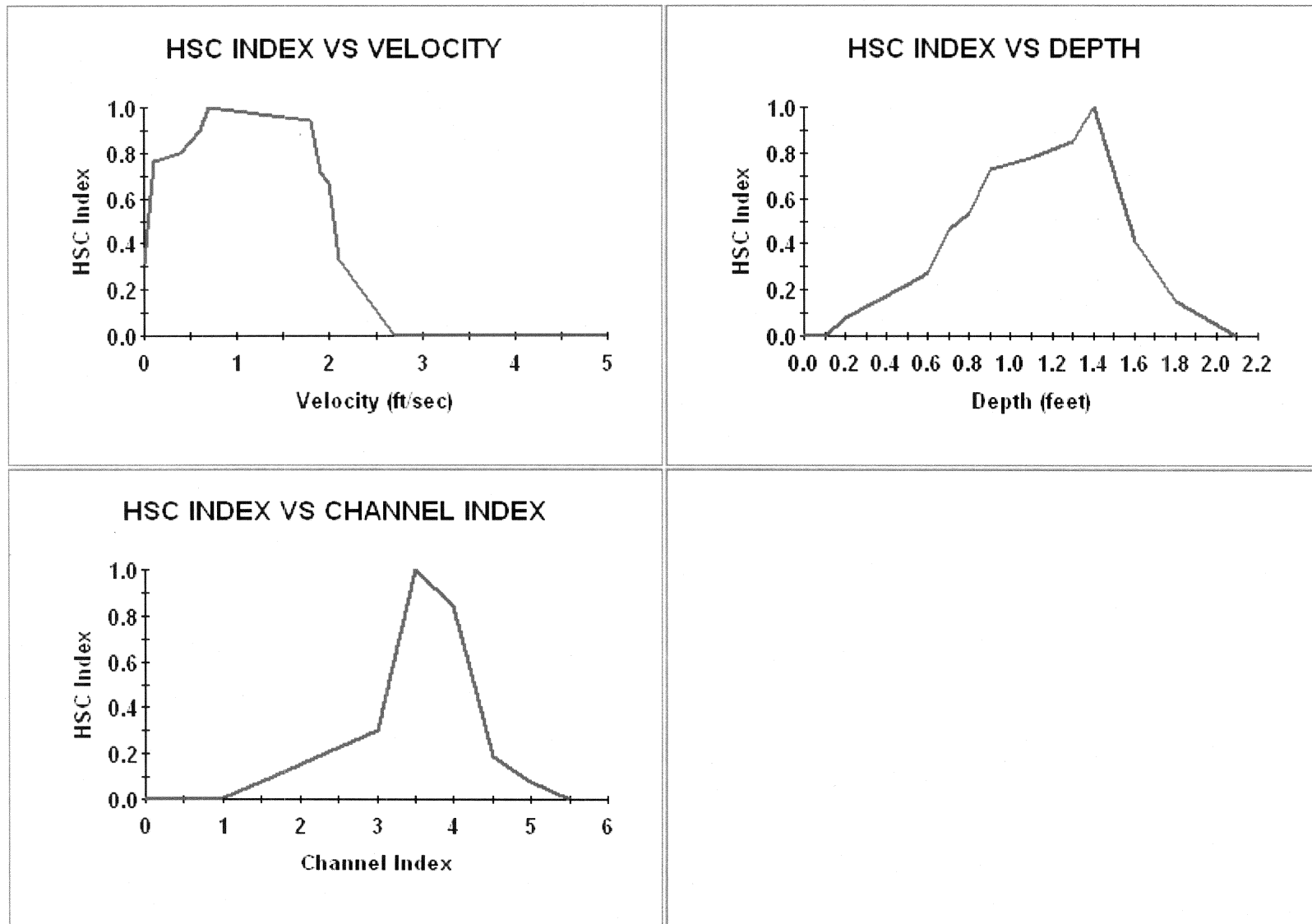
Channel Catfish - Adult



November 17, 2006

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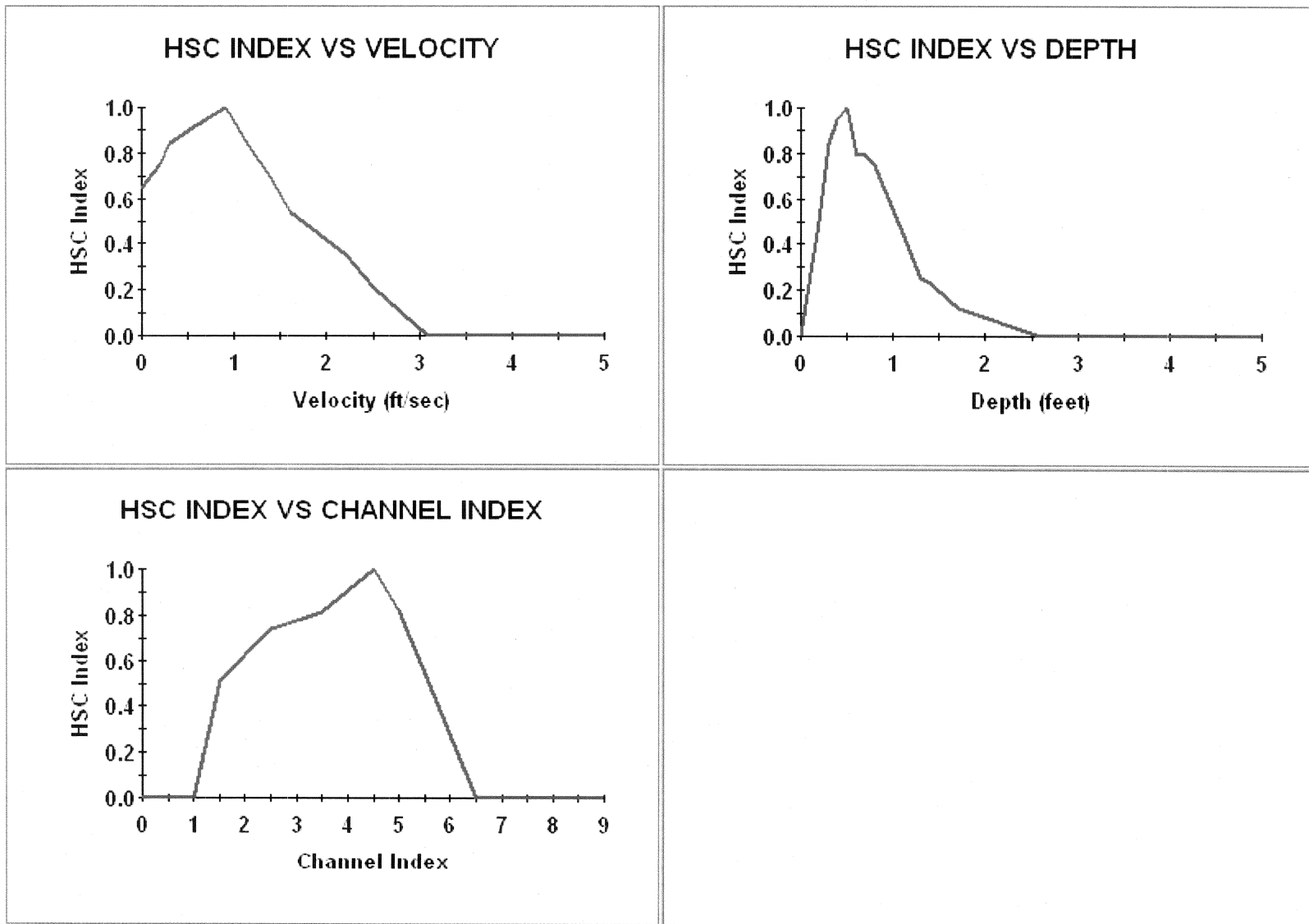
Channel Catfish - Juvenile



November 17, 2006

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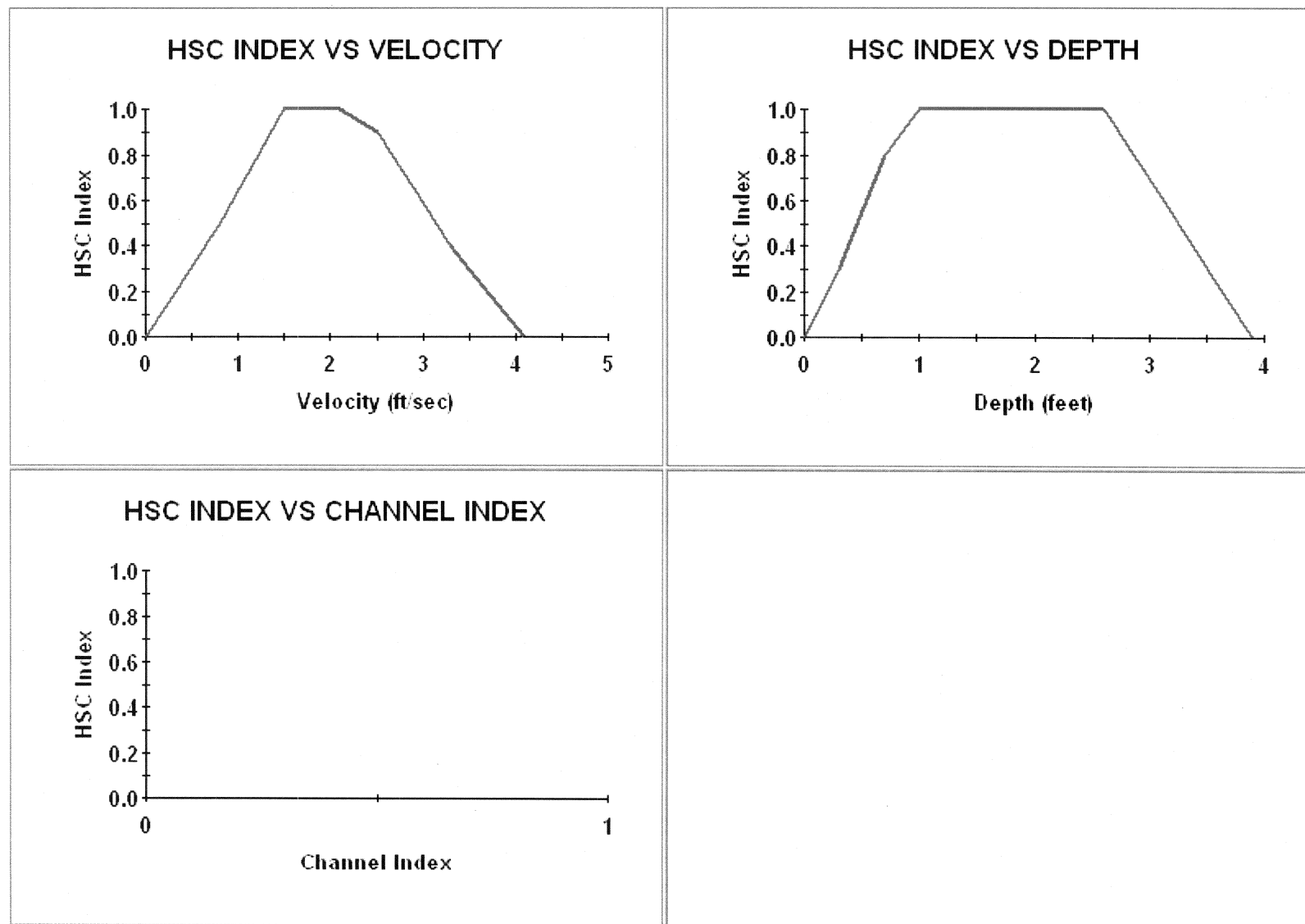
Sand Shiner - Adult



November 17, 2006

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Revision

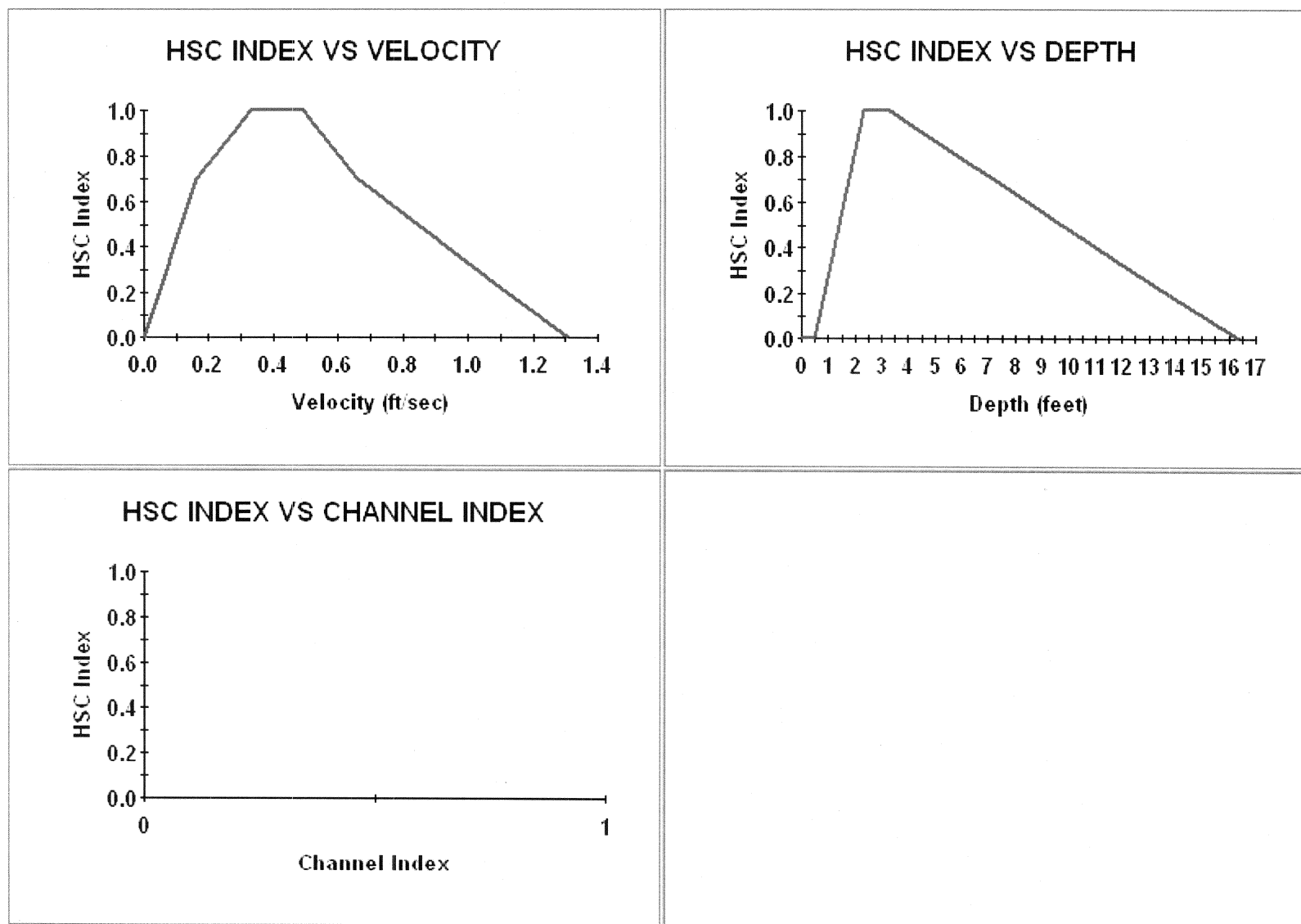
Longnose Dace - Adult



November 17, 2006

Preliminary Results— Subject to
Revision

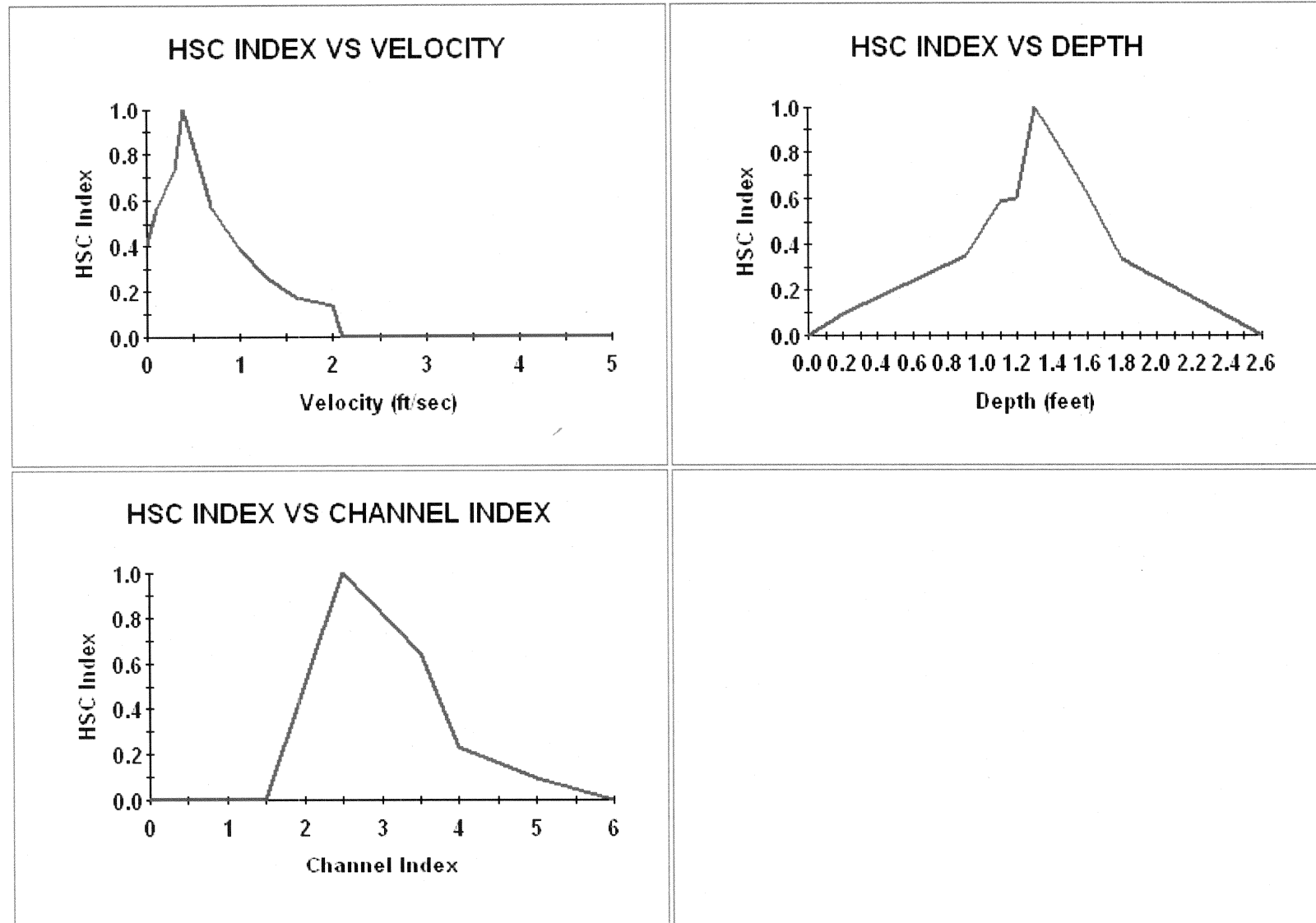
White Sucker – Juvenile/Adult



November 17, 2006

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Common Carp - Adult



November 17, 2006

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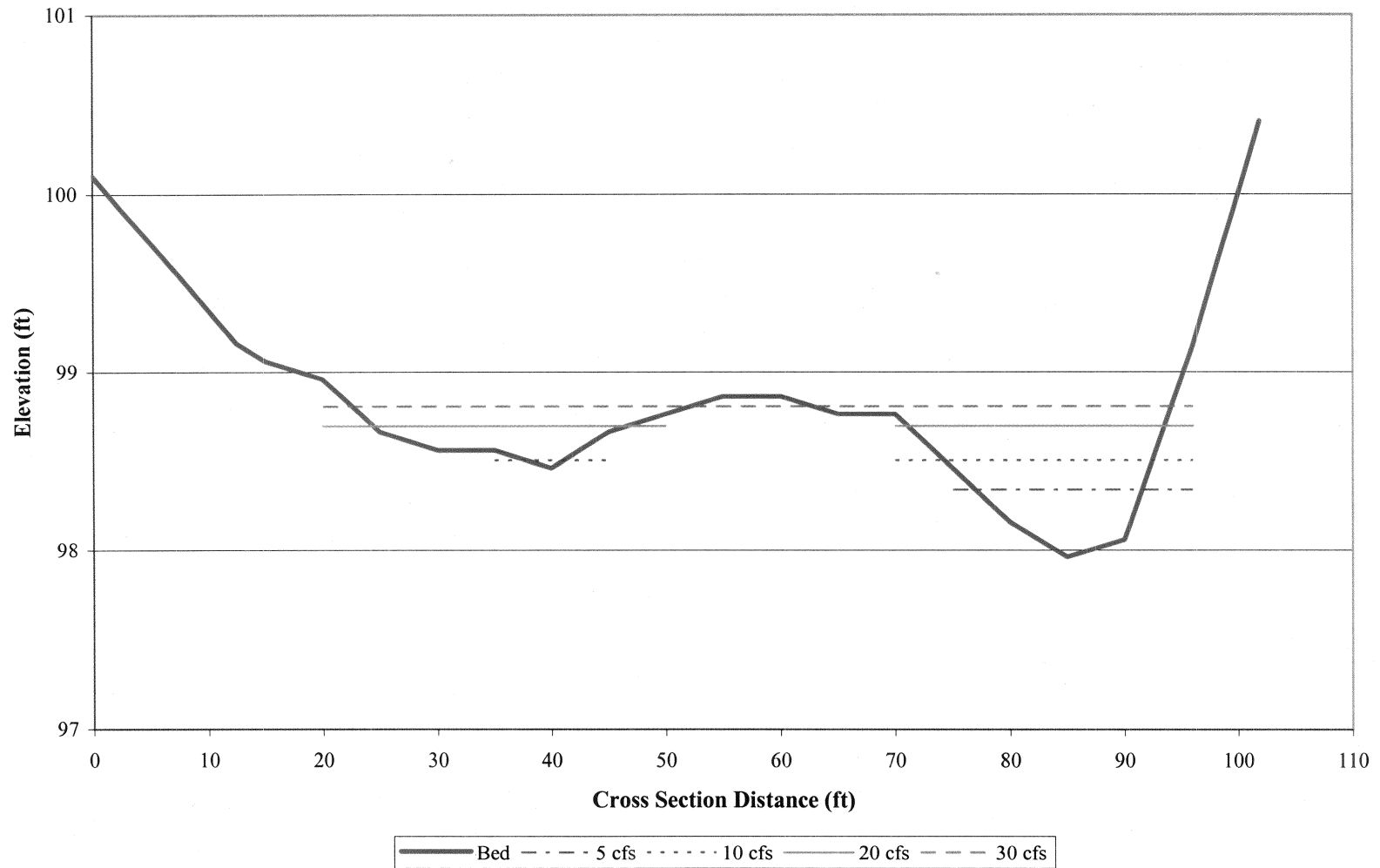
Attachment B

Cross Section Flow and Wetted Perimeter Analysis

Cross section analysis

- Plotted water surface for 5, 10, 20, and 30 cfs for riffle and run cross section.

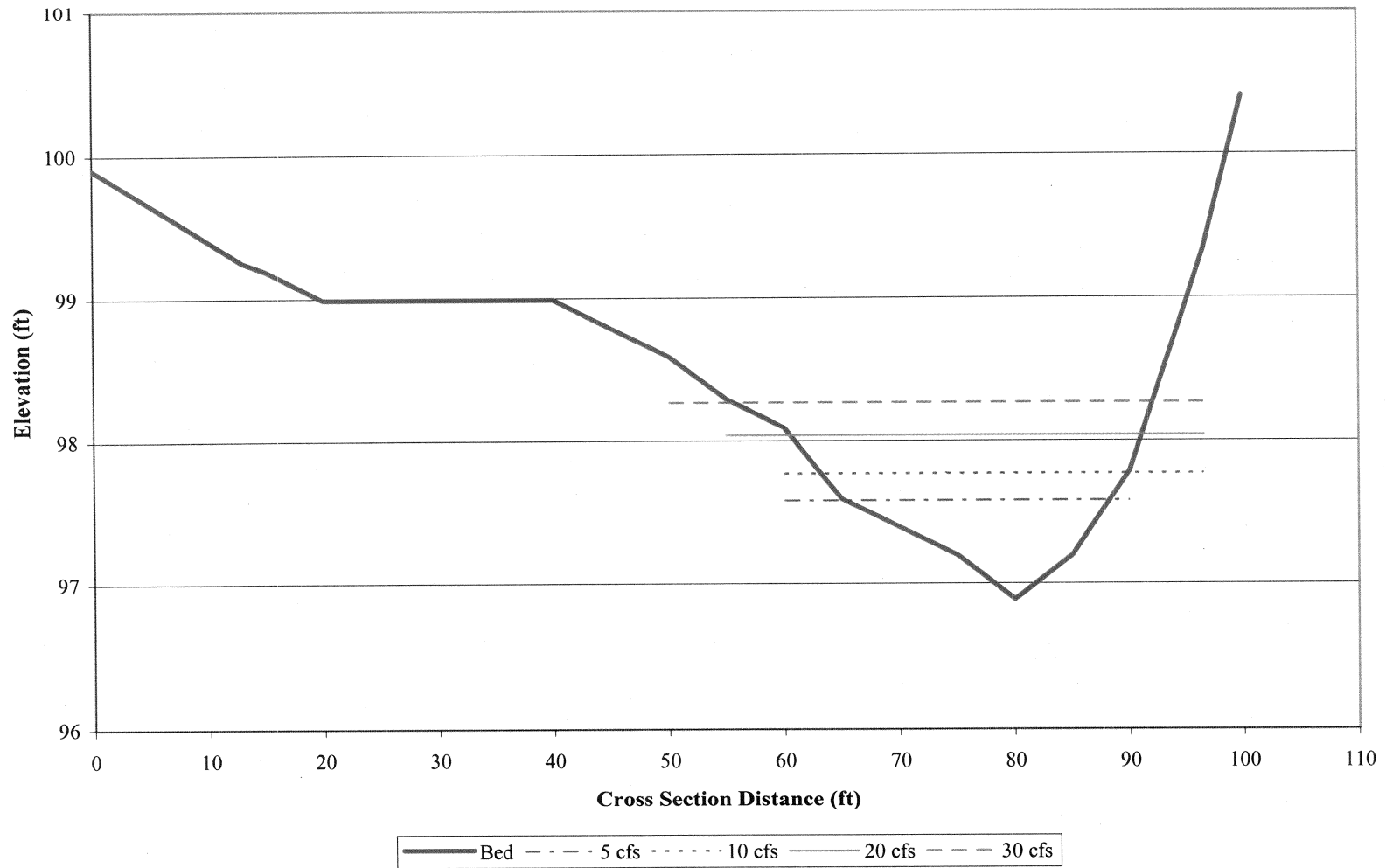
South Platte Littleton Bed Profile, Water Surface Elevation - Riffle



November 17, 2006

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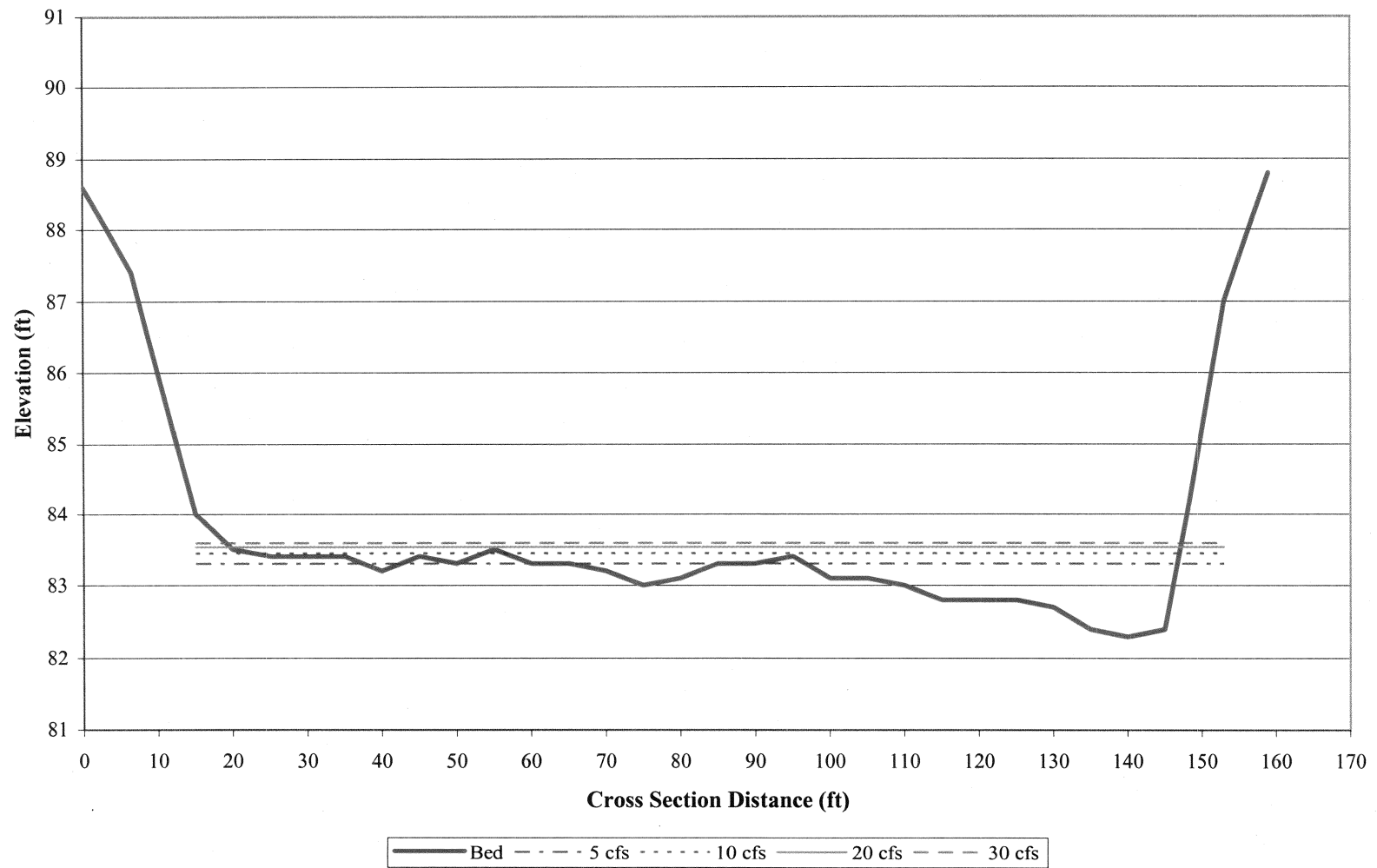
South Platte Littleton Bed Profile, Water Surface Elevation - Run



November 17, 2006

Preliminary Results— Subject to
Revision

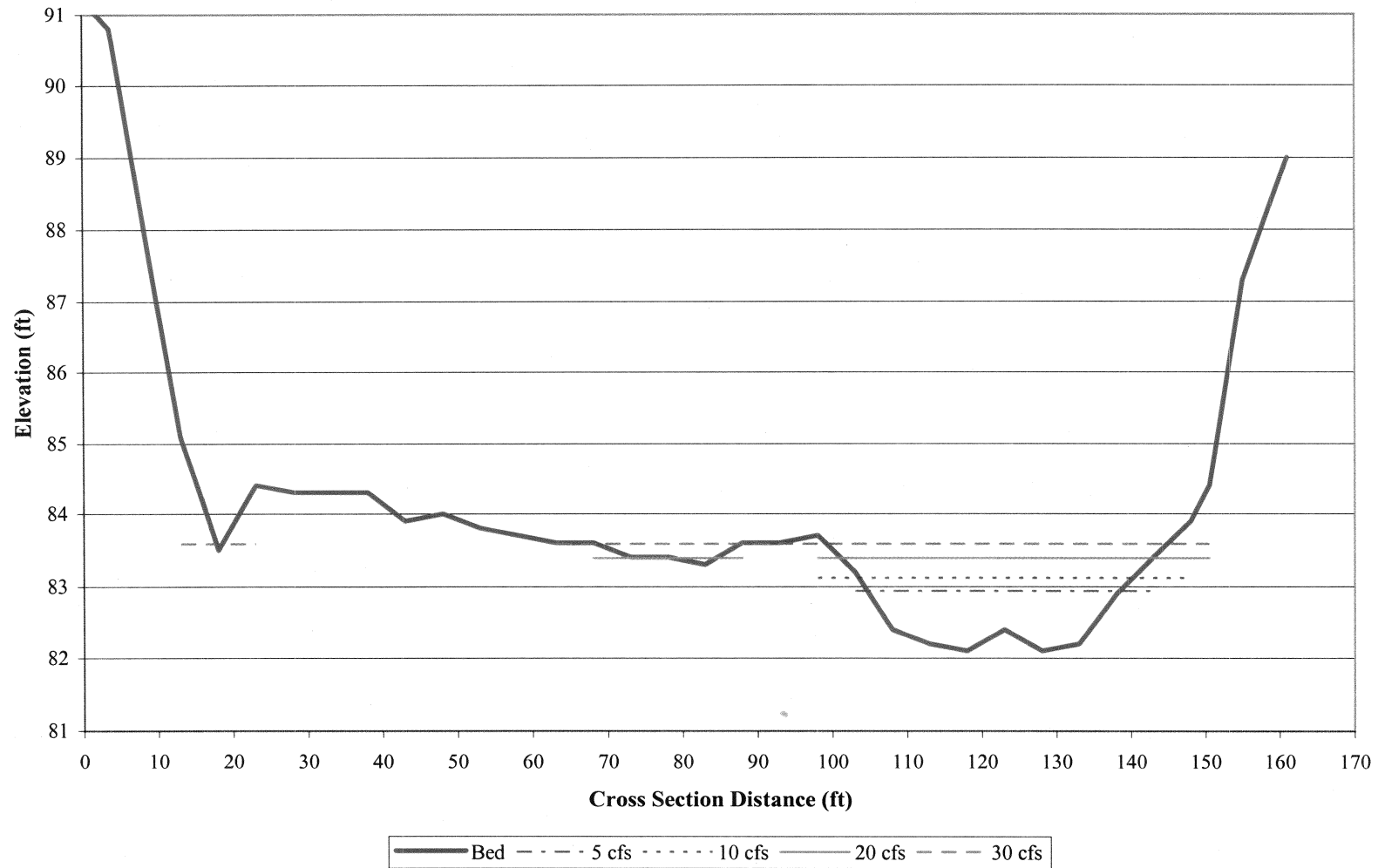
South Platte at Union St. Bed Profile, Water Surface Elevation - Riffle



November 17, 2006

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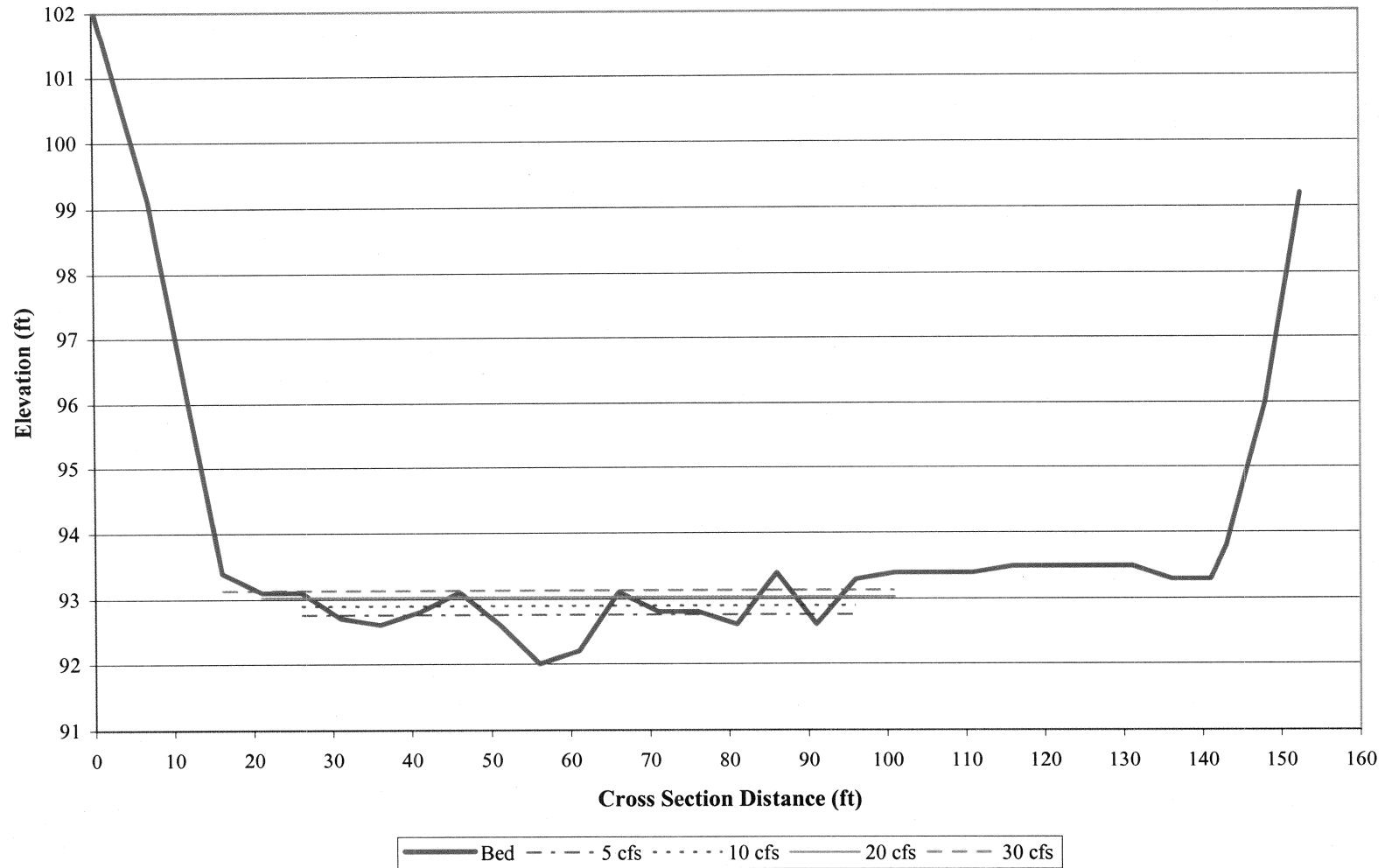
South Platte at Union St. Bed Profile, Water Surface Elevation - Run



November 17, 2006

Preliminary Results— Subject to
Revision

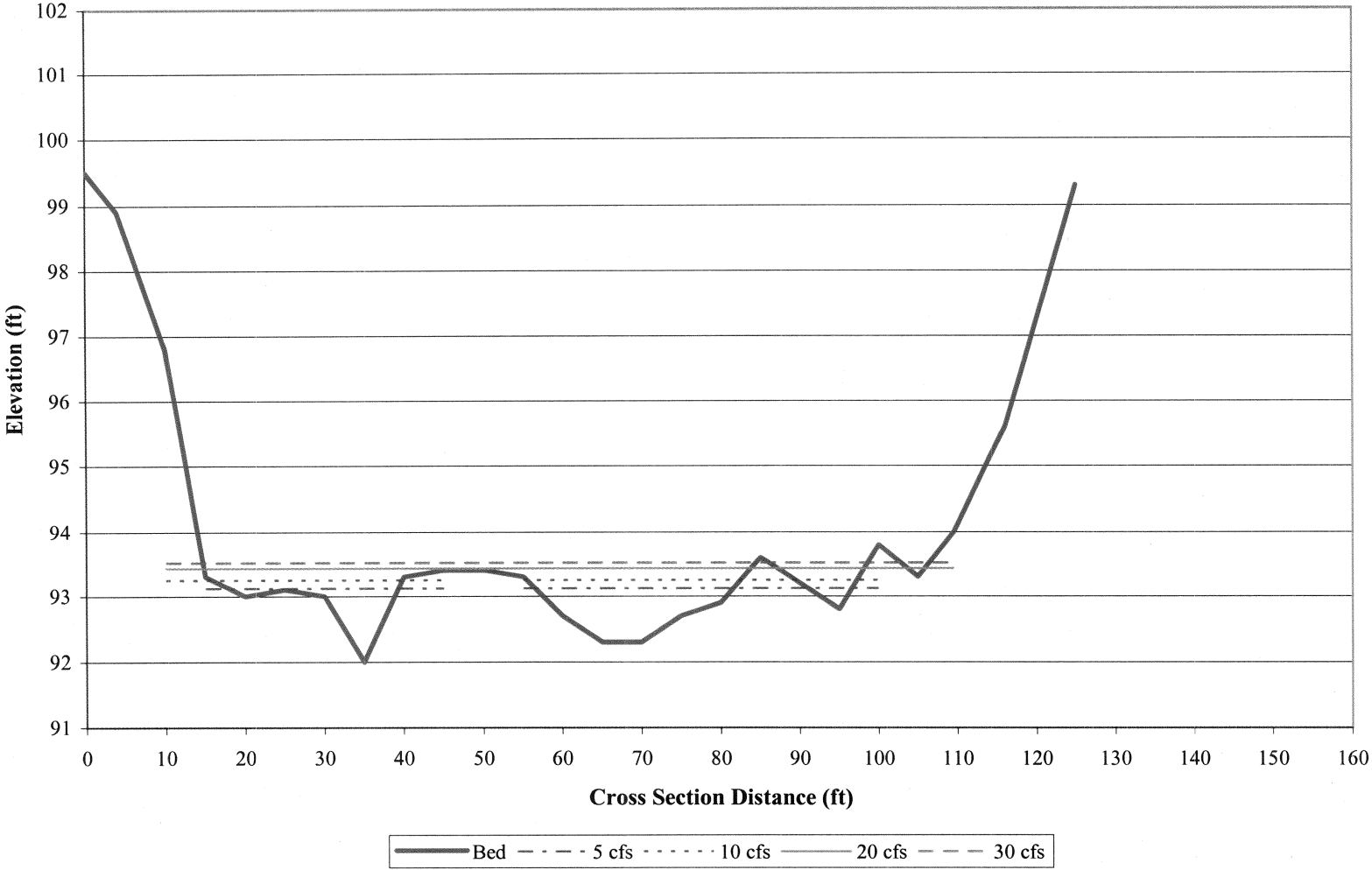
South Platte at Evans St. Bed Profile, Water Surface Elevation - Riffle



November 17, 2006

Preliminary Results— Subject to
Revision

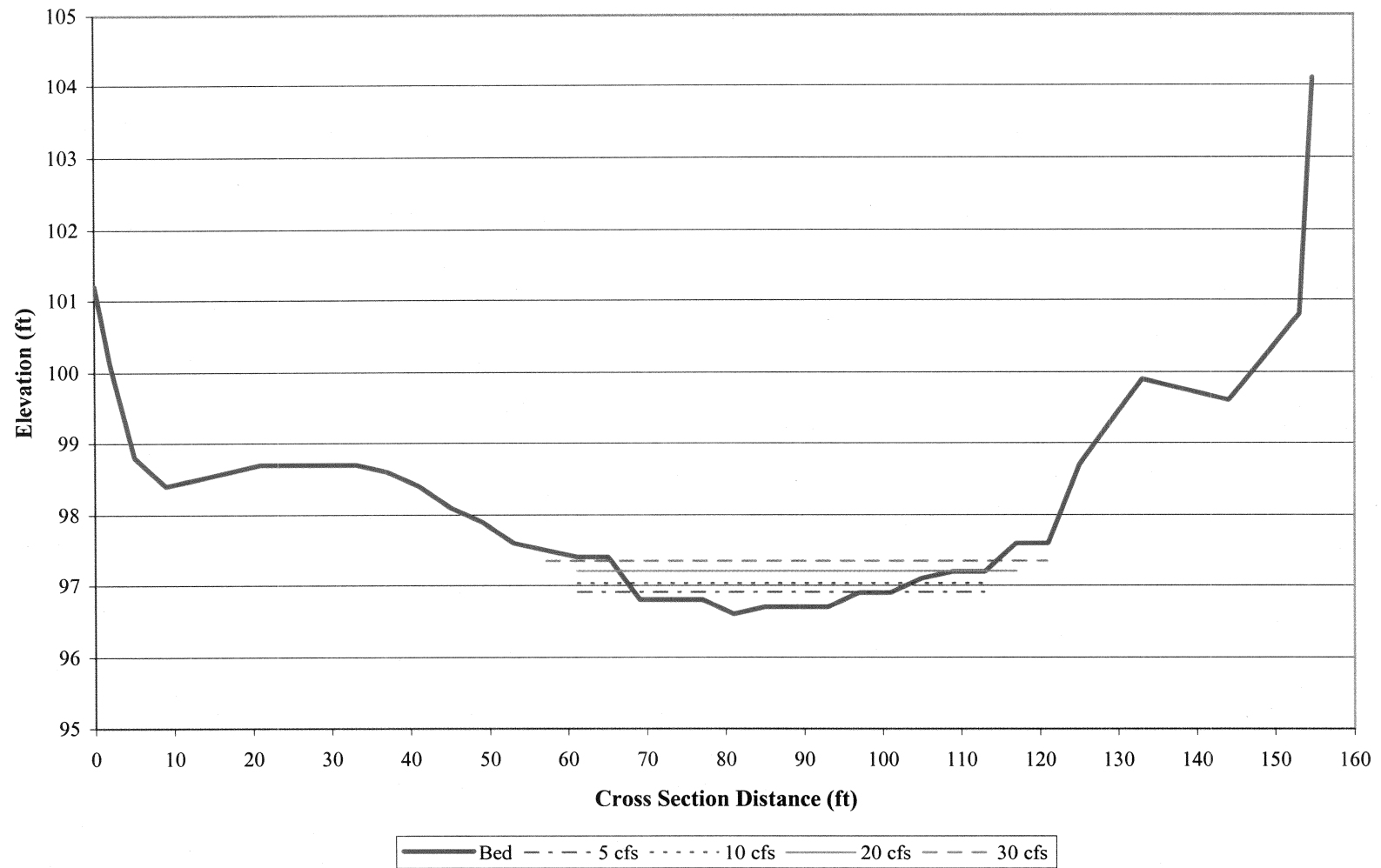
South Platte at Evans St. Bed Profile, Water Surface Elevation - Run



November 17, 2006

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Revision

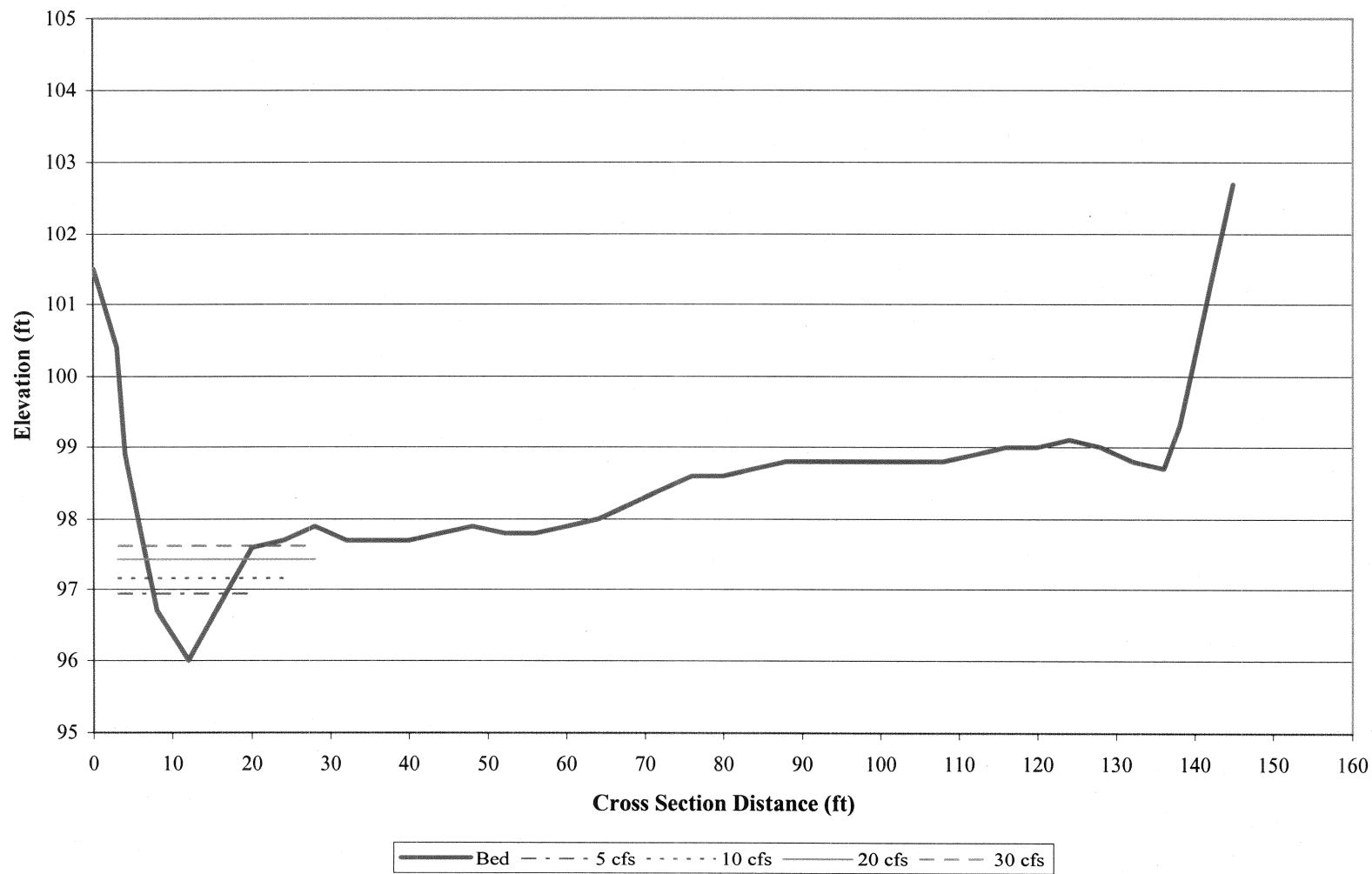
South Platte at Franklin St. Bed Profile, Water Surface Elevation - Riffle



November 17, 2006

Preliminary Results – Subject to
Revision

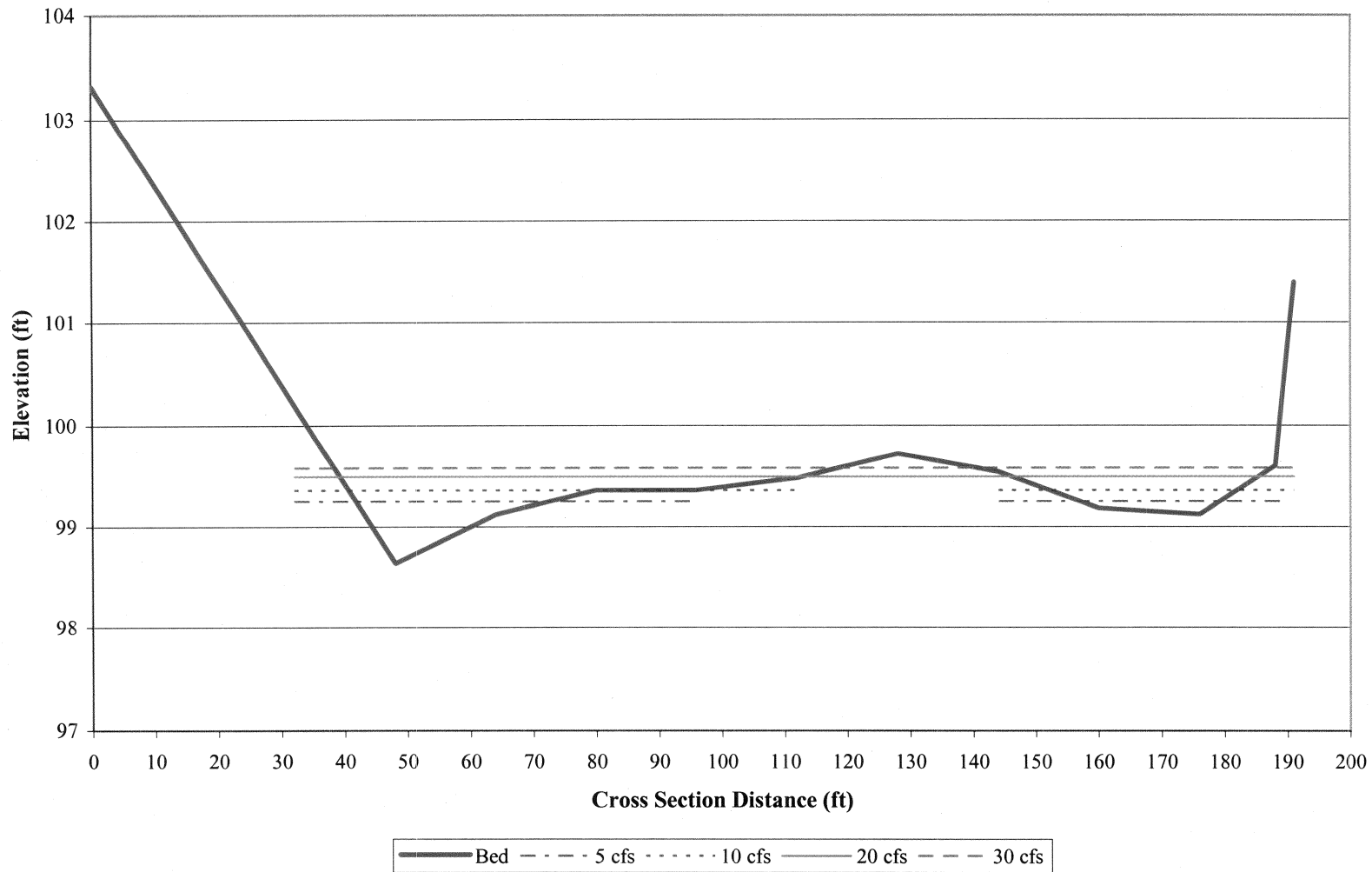
South Platte at Franklin St. Bed Profile, Water Surface Elevation - Run



November 17, 2006

Preliminary Results— Subject to
Revision

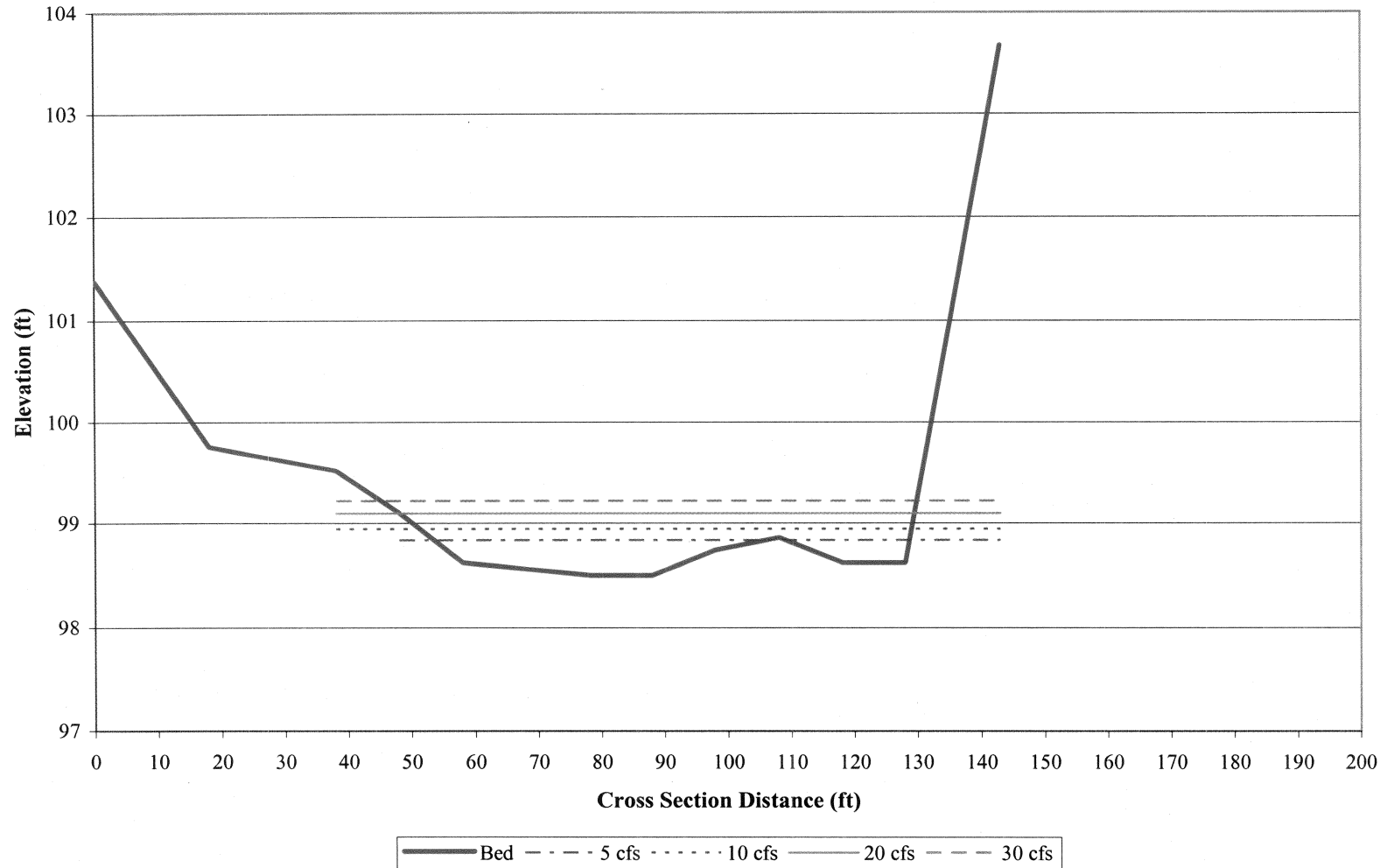
South Platte Downstream Bed Profile, Water Surface Elevation - Riffle



November 17, 2006

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South Platte Downstream Bed Profile, Water Surface Elevation - Run



November 17, 2006

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Revision

Draft for Discussion Purposes Only

Attachment C

Habitat Flow Relationships

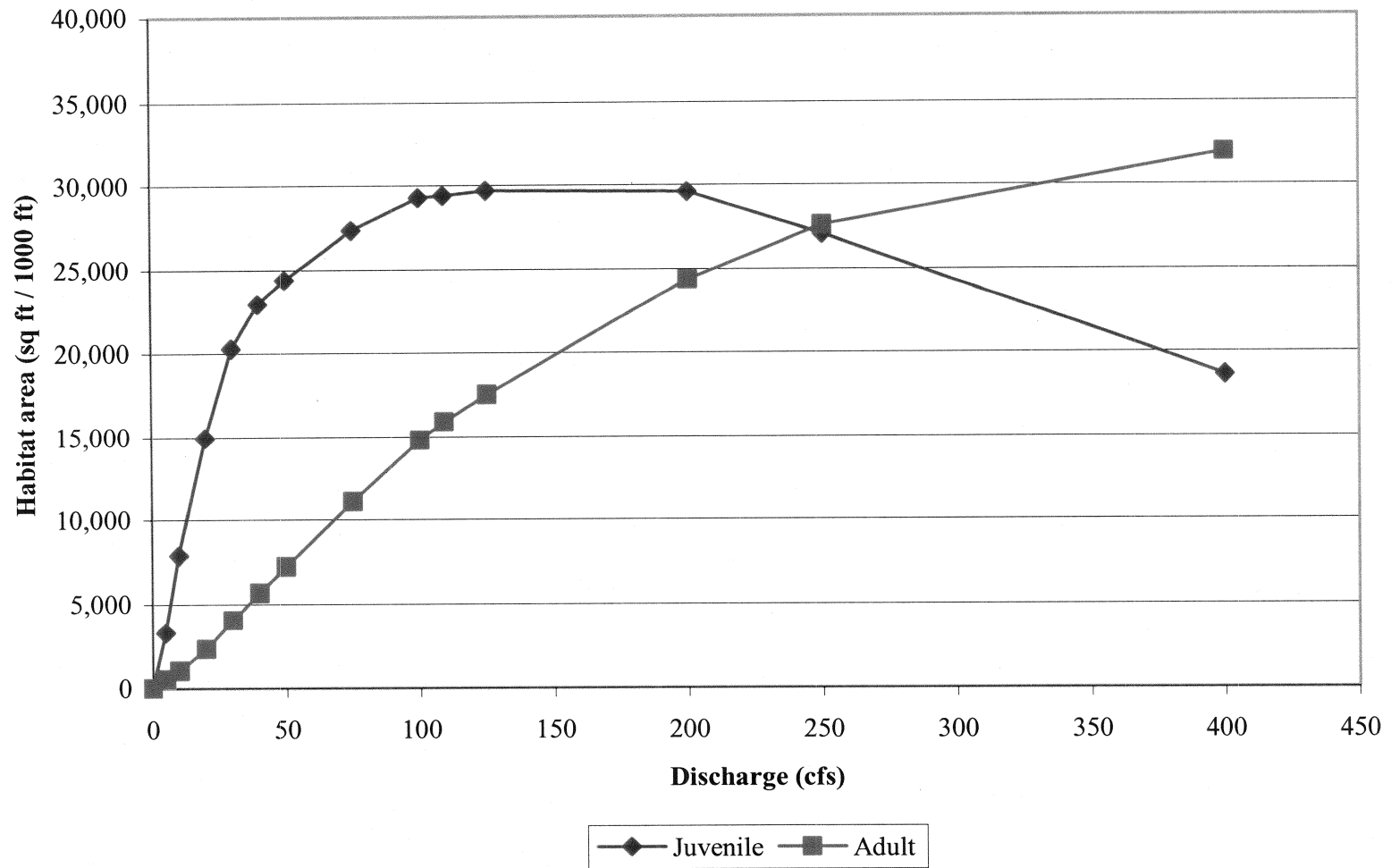
Habitat flow relationships

Southern reaches

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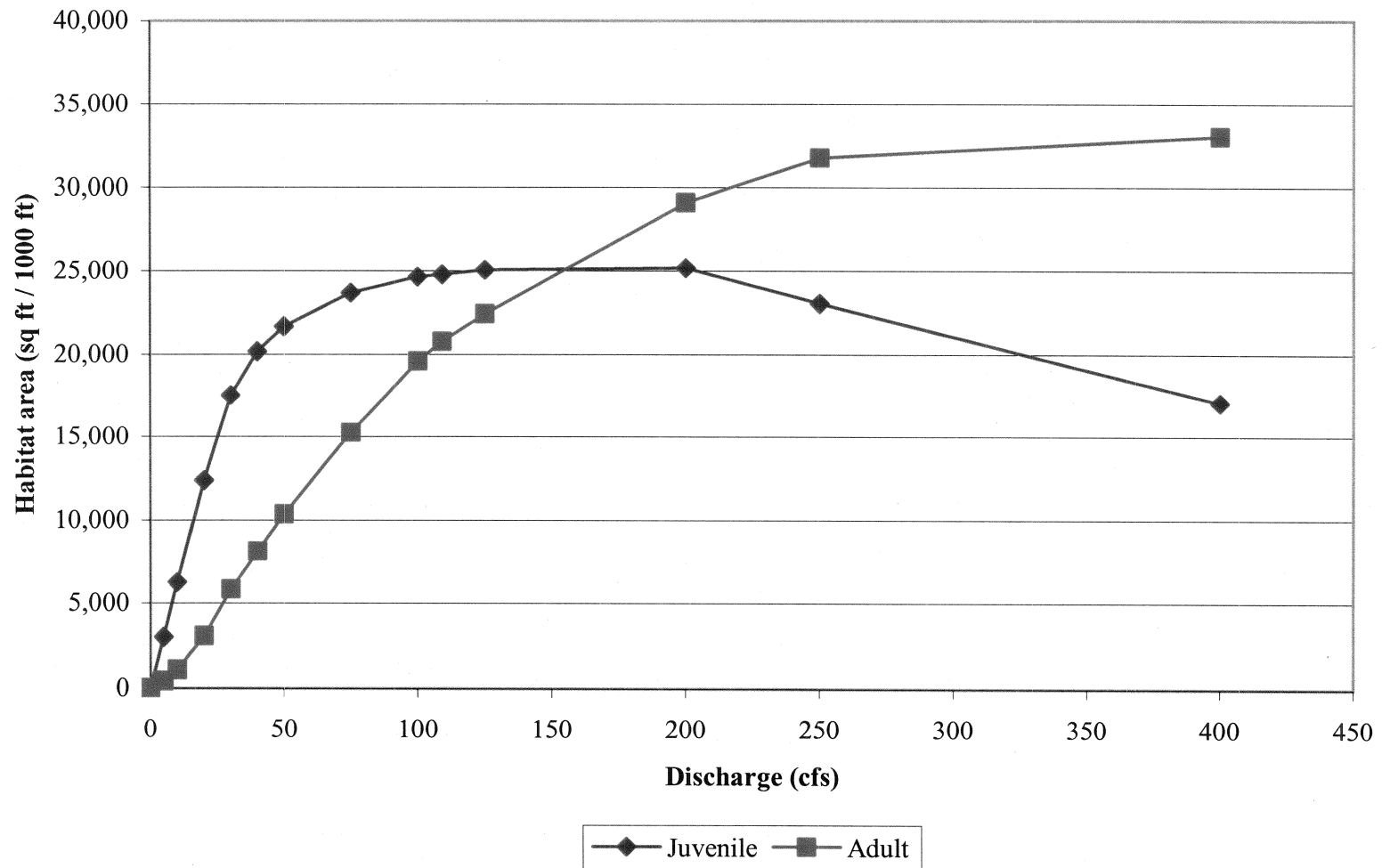
Rainbow Trout Habitat versus Discharge, S. Platte Littleton



November 17, 2006

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Revision

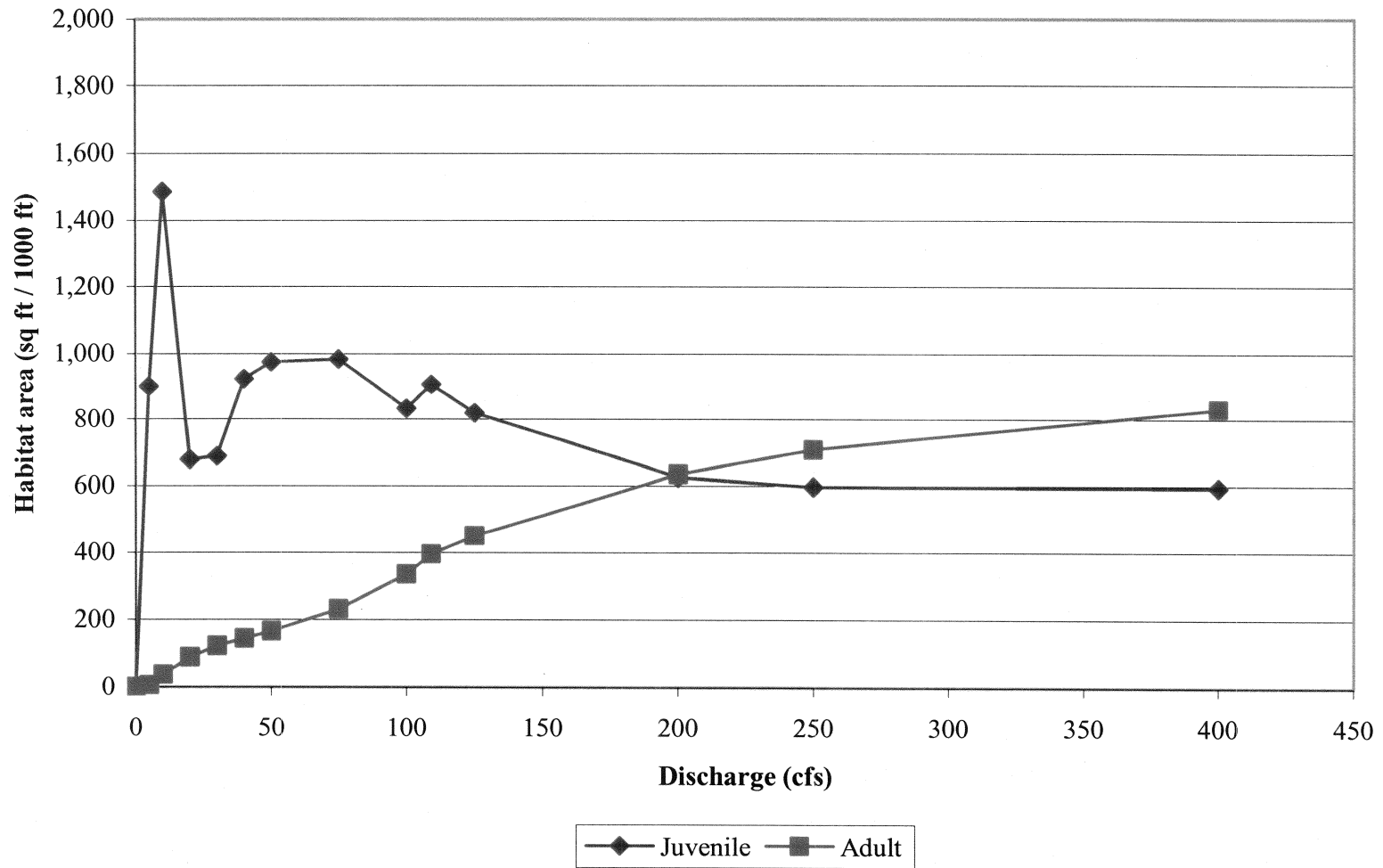
Brown Trout Habitat versus Discharge, S. Platte Littleton



November 17, 2006

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Revision

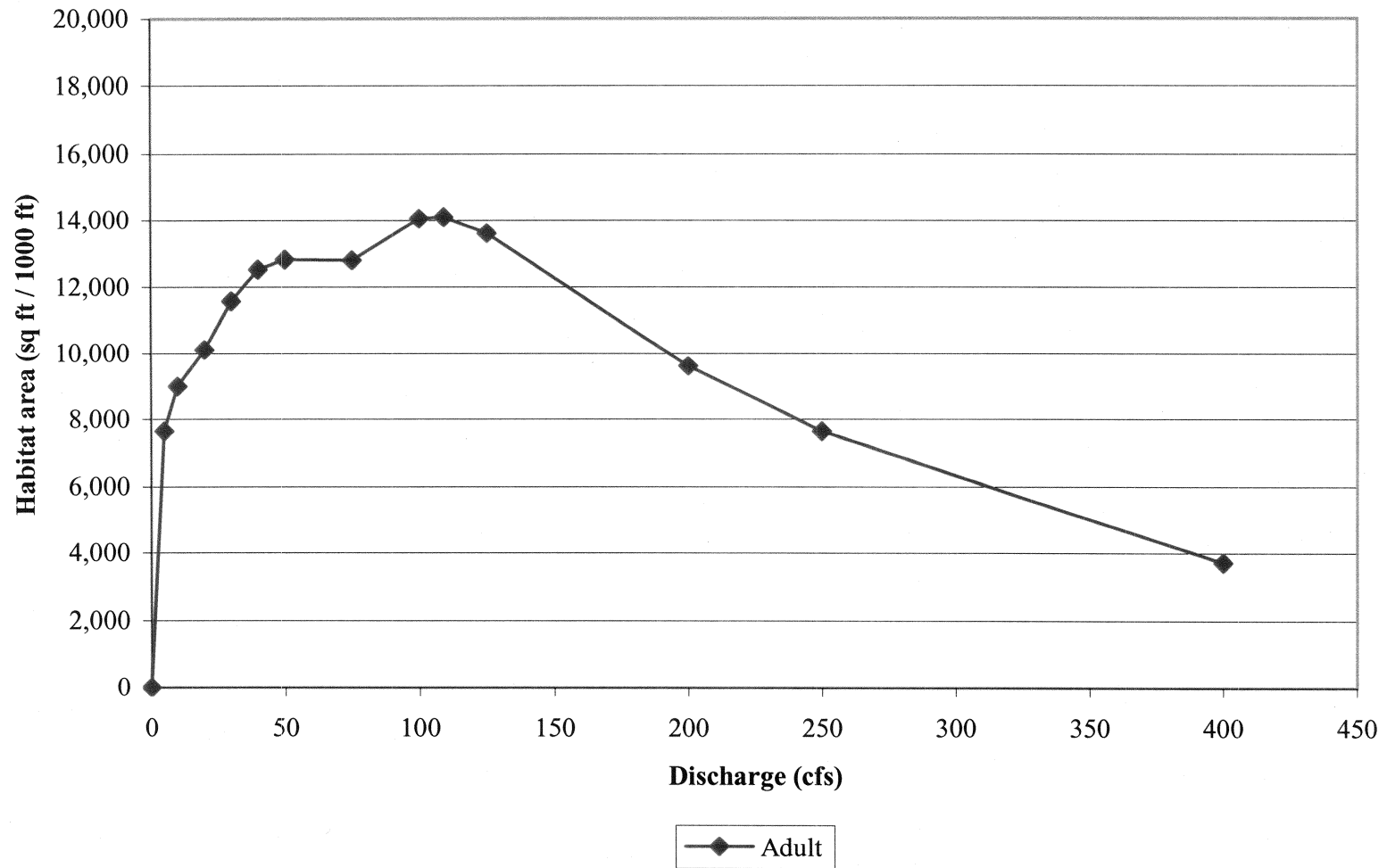
Channel Catfish Habitat versus Discharge, S. Platte Littleton



November 17, 2006

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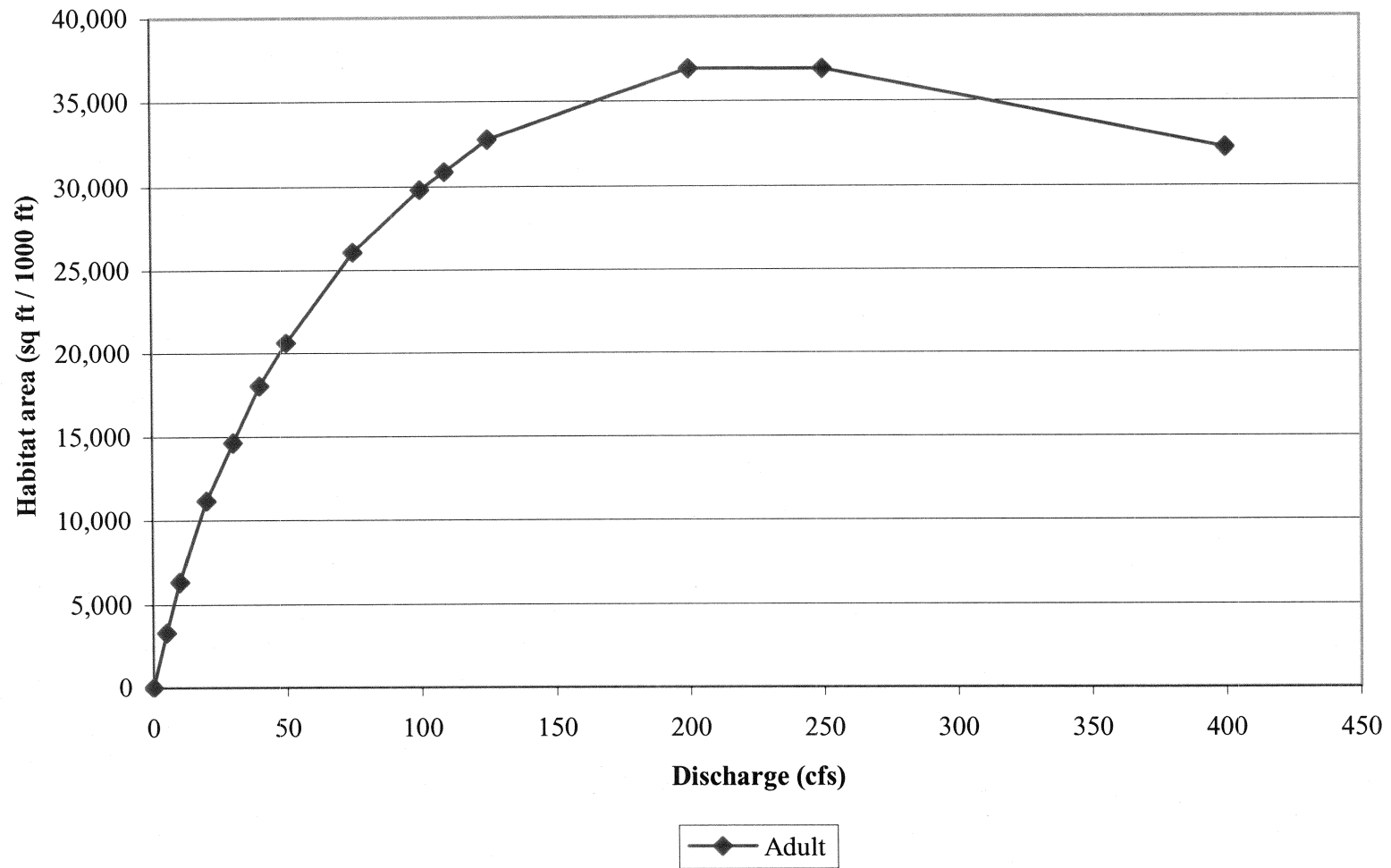
Sand Shiner Habitat versus Discharge, S. Platte Littleton



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Preliminary Results– Subject to
Revision

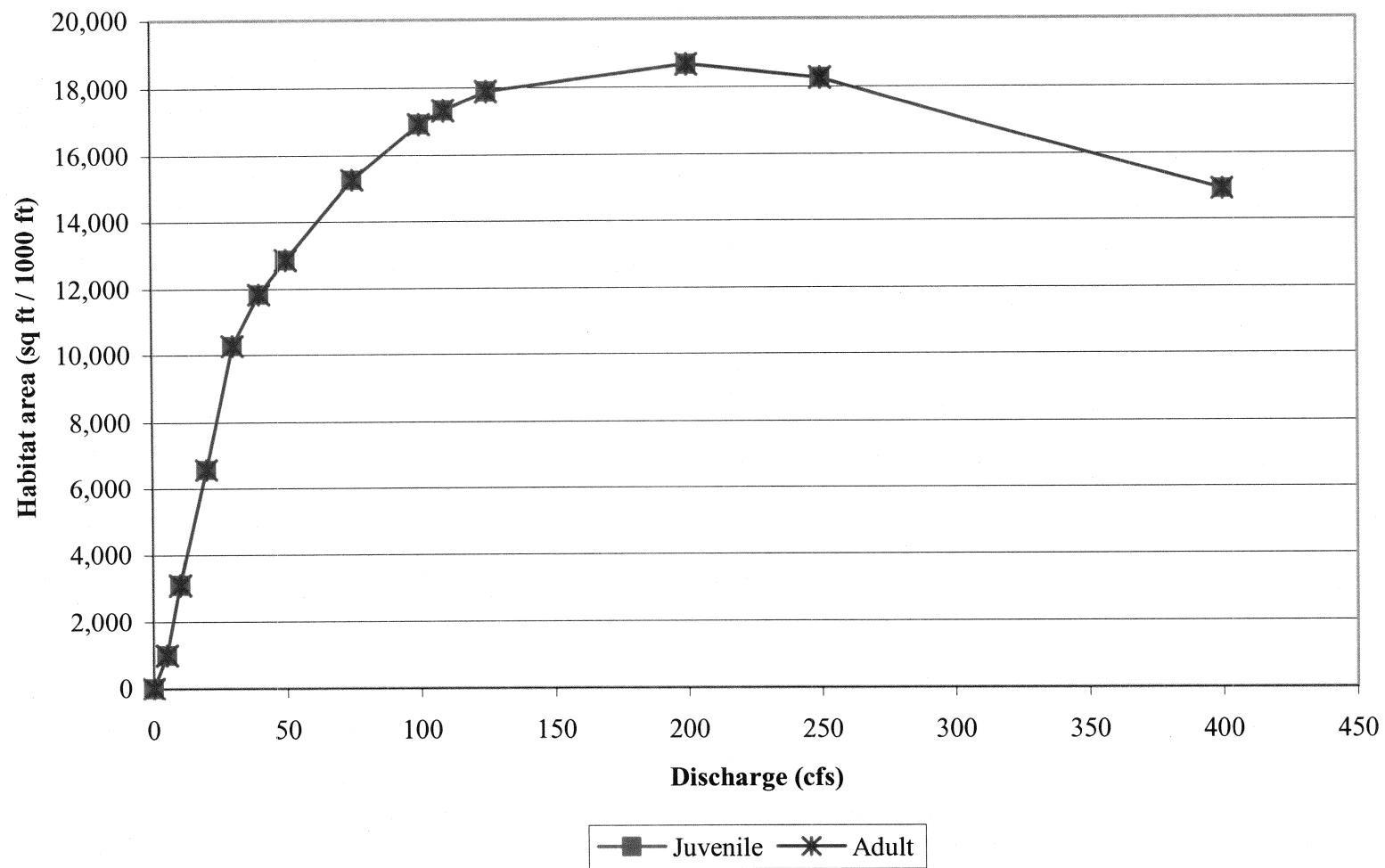
Longnose Dace Habitat versus Discharge, S. Platte Littleton



November 17, 2006

Preliminary Results – Subject to
Revision

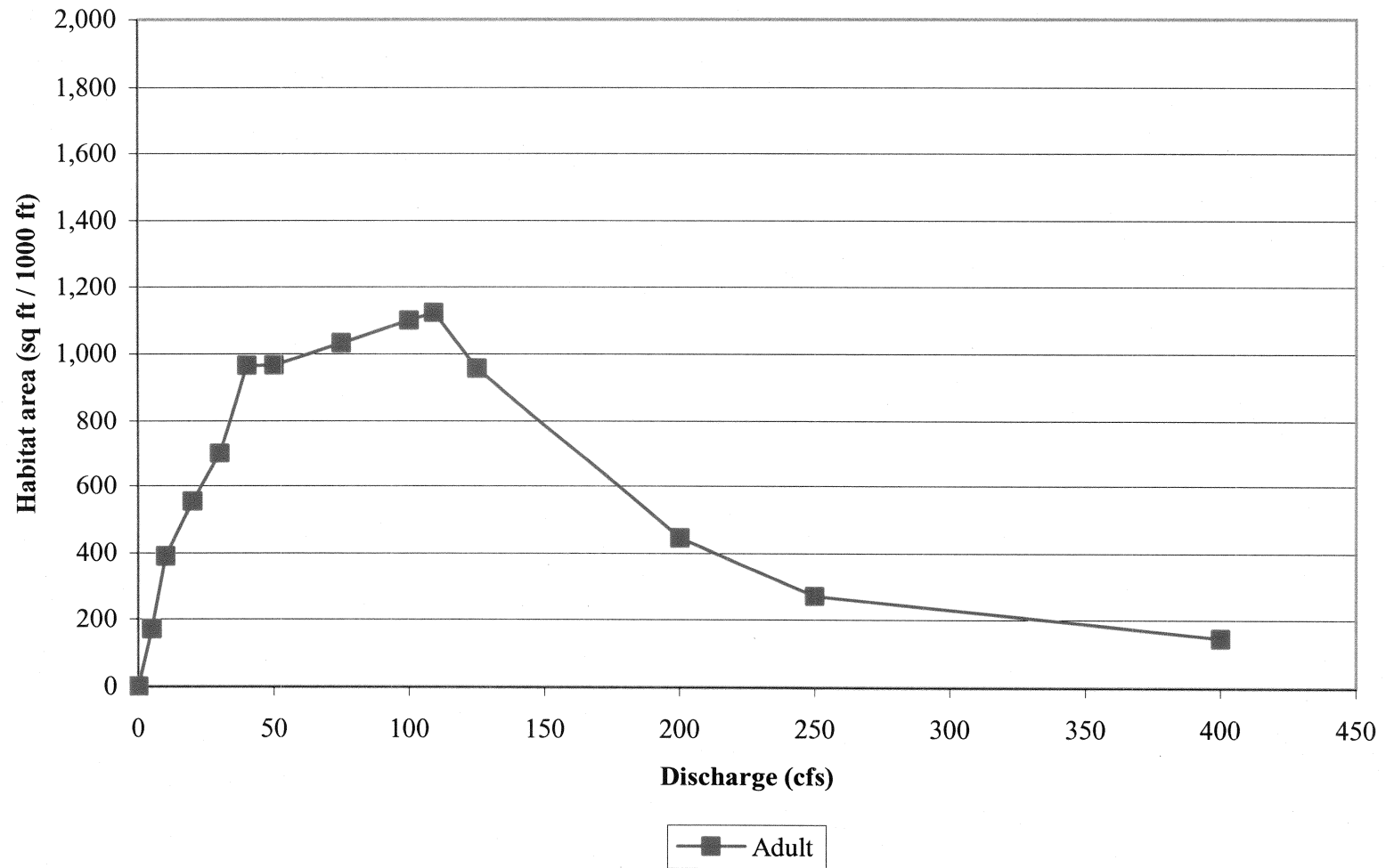
White Sucker Habitat versus Discharge, S. Platte Littleton



November 17, 2006

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Common Carp Habitat versus Discharge, S. Platte Littleton



November 17, 2006

Preliminary Results— Subject to
Revision

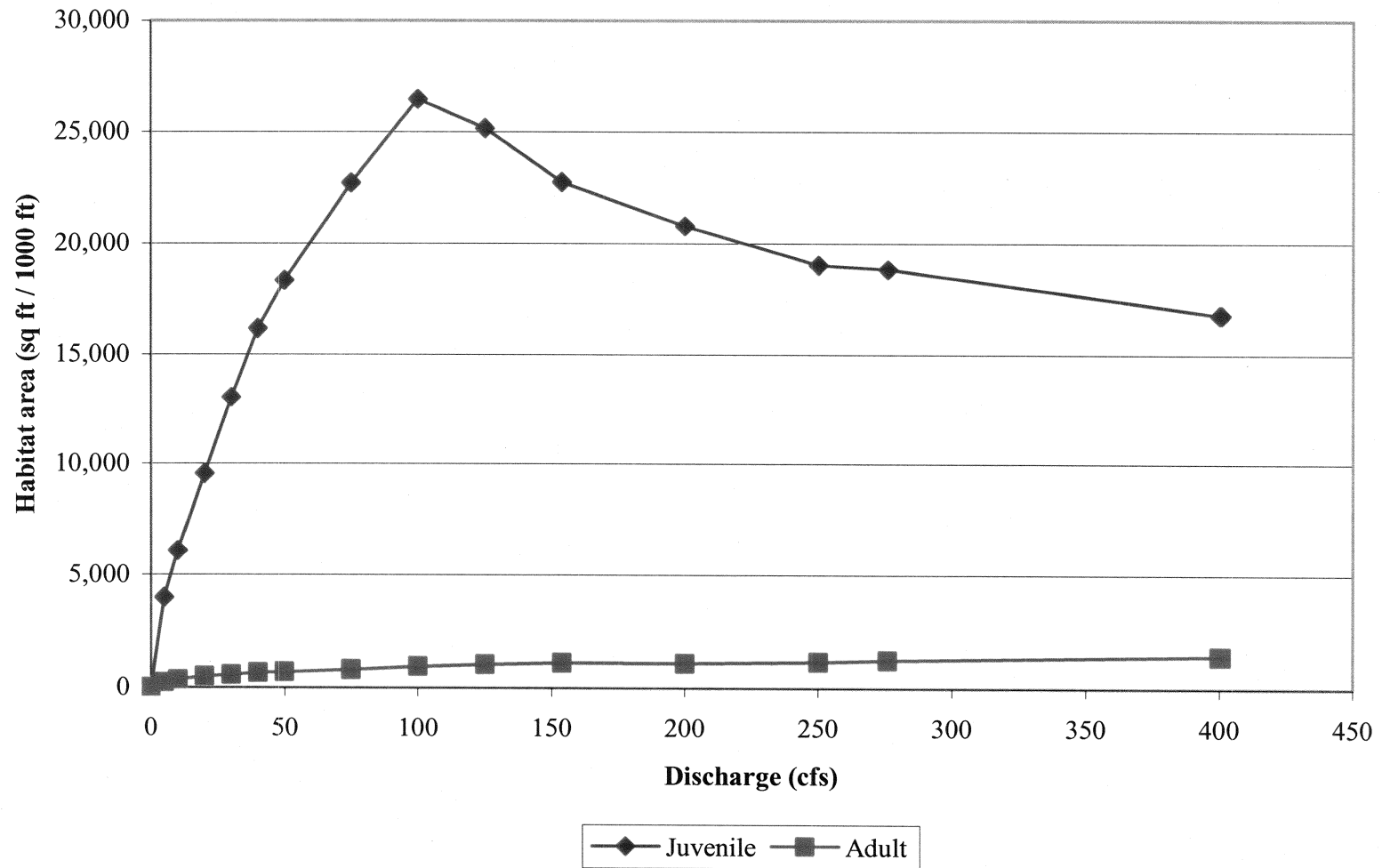
Habitat flow relationships

Middle reaches

November 17, 2006

Preliminary Results— Subject to
Revision

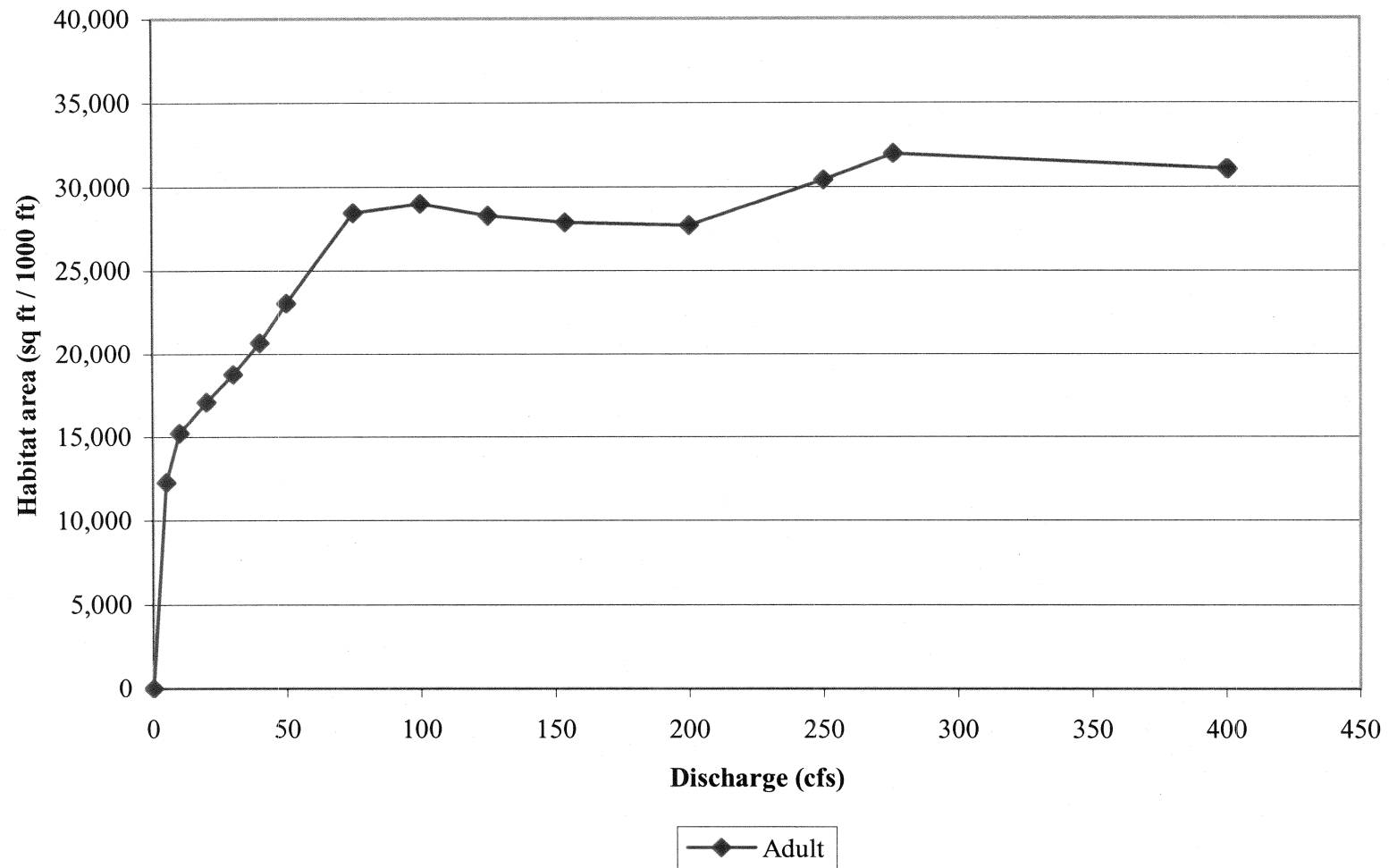
Channel Catfish Habitat versus Discharge, S. Platte Franklin St.



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Preliminary Results– Subject to
Revision

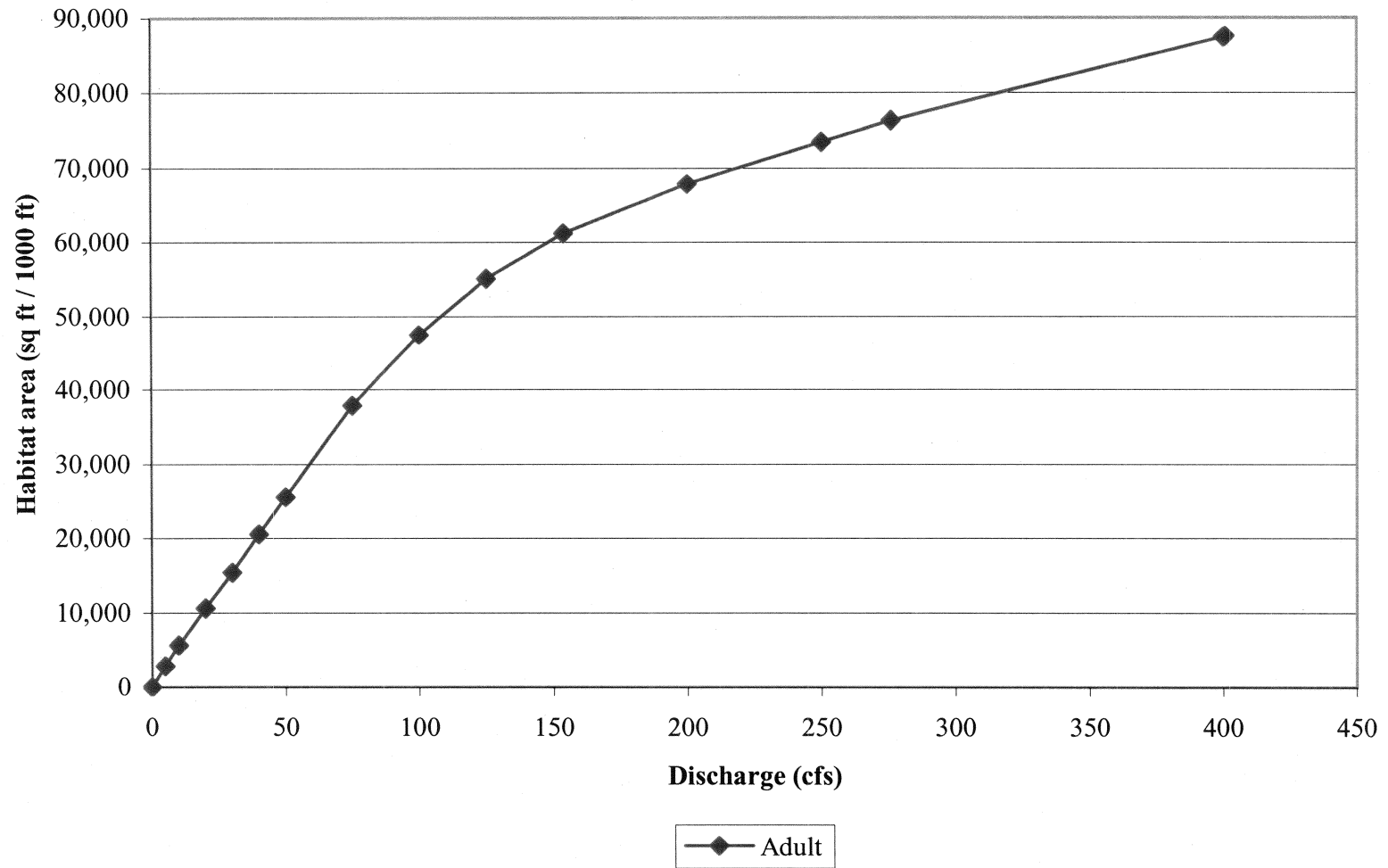
Sand Shiner Habitat versus Discharge, S. Platte Franklin St.



November 17, 2006

Preliminary Results – Subject to
Revision

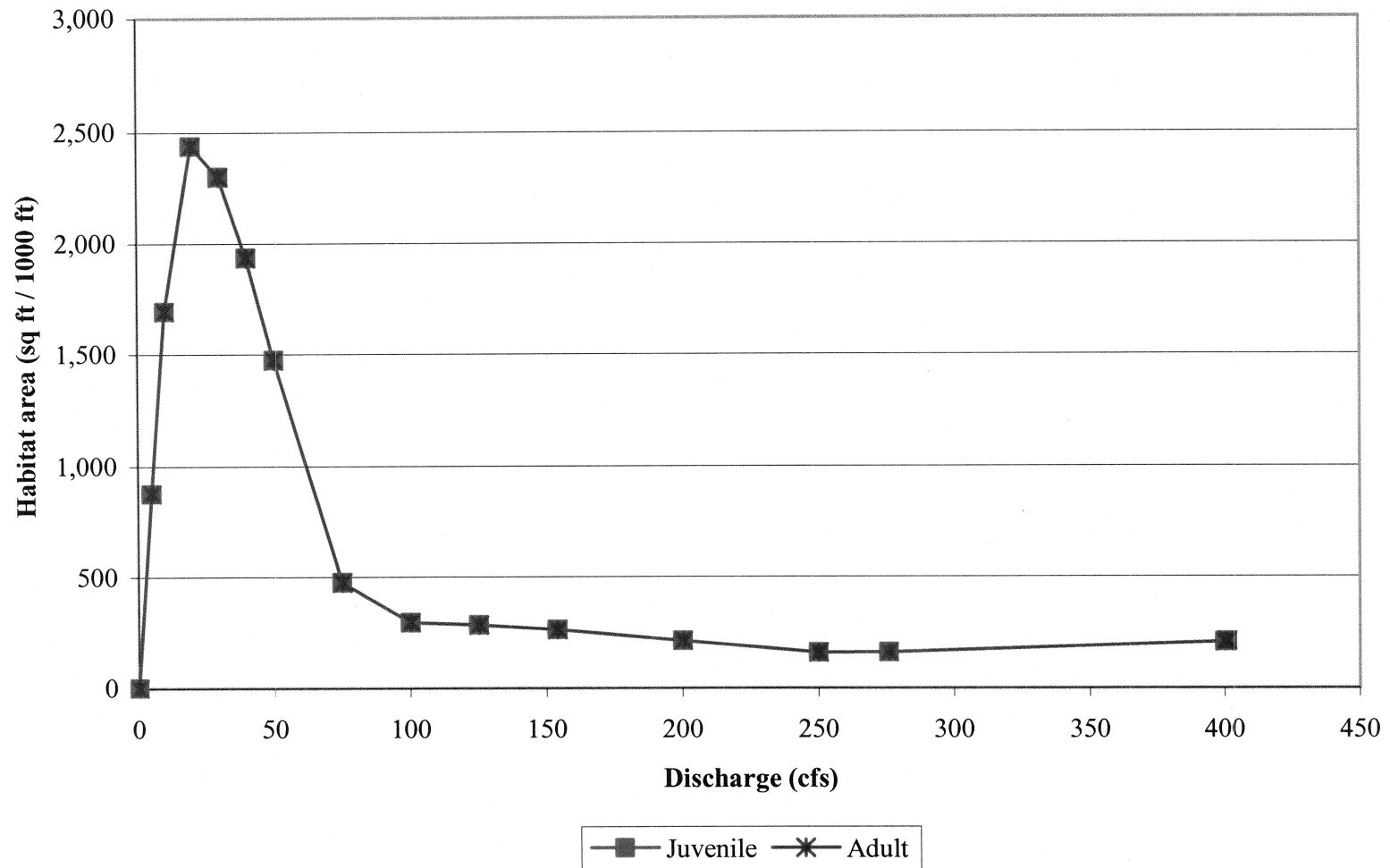
Longnose Dace Habitat versus Discharge, S. Platte Franklin St.



November 17, 2006

Preliminary Results – Subject to
Revision

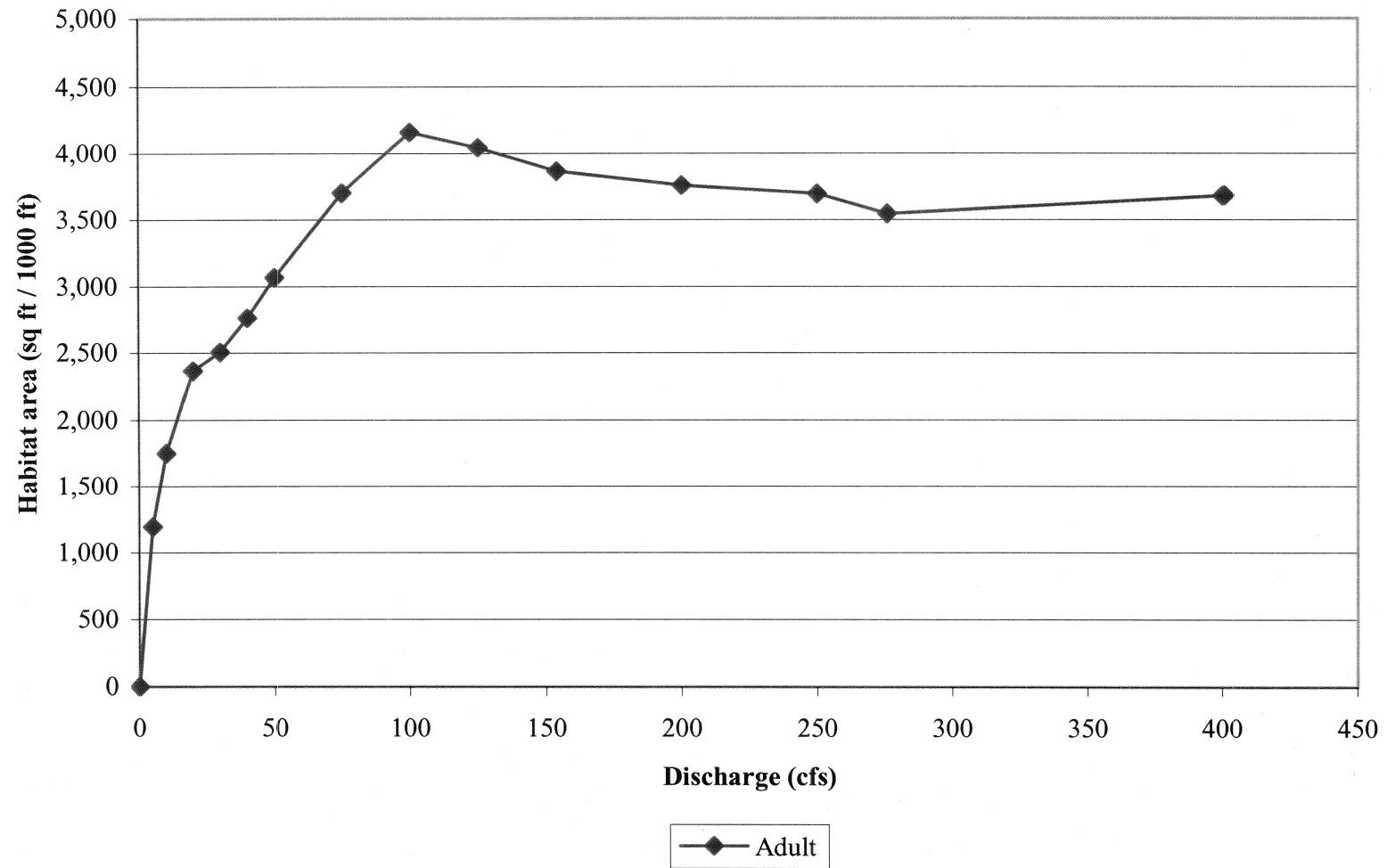
White Sucker Habitat versus Discharge, S. Platte Franklin St.



November 17, 2006

Preliminary Results— Subject to
Revision

Common Carp Habitat versus Discharge, S. Platte Franklin St.



November 17, 2006

Preliminary Results – Subject to
Revision

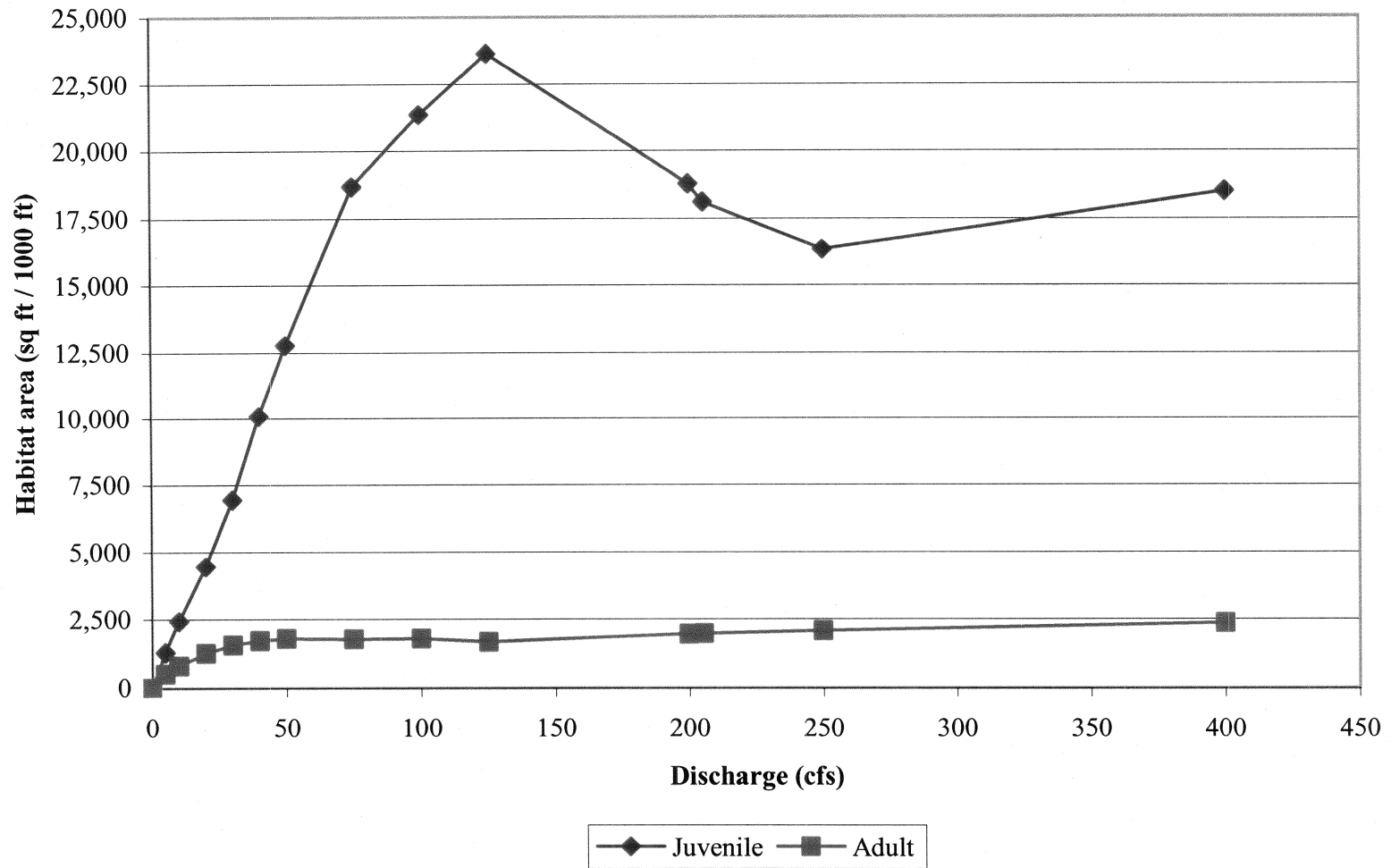
Habitat flow relationships

Northeastern reaches

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Preliminary Results – Subject to
Revision

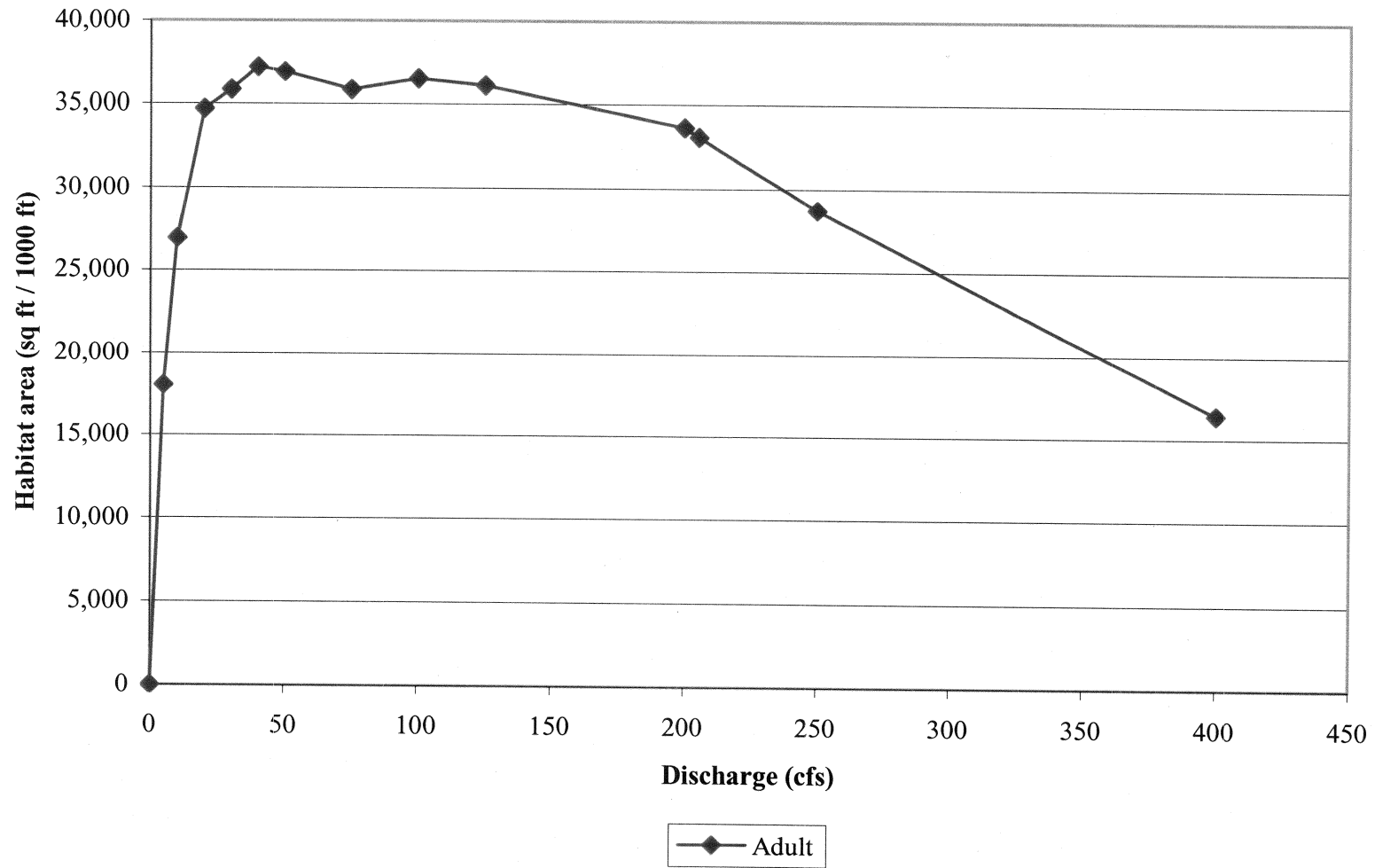
Channel Catfish Habitat versus Discharge, S. Platte Downstream



November 17, 2006

Preliminary Results— Subject to
Revision

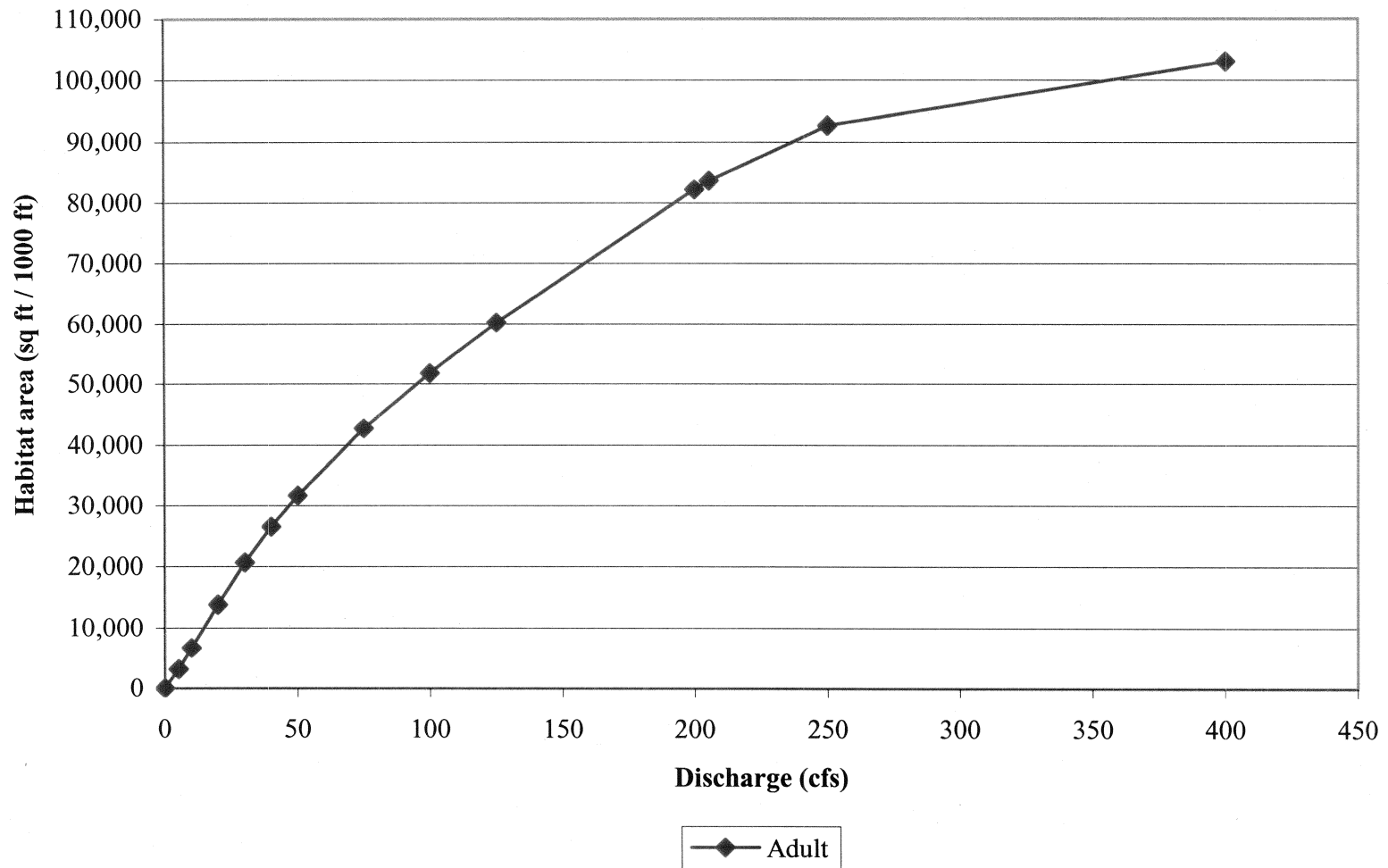
Sand Shiner Habitat versus Discharge, S. Platte Downstream



November 17, 2006

Preliminary Results— Subject to
Revision

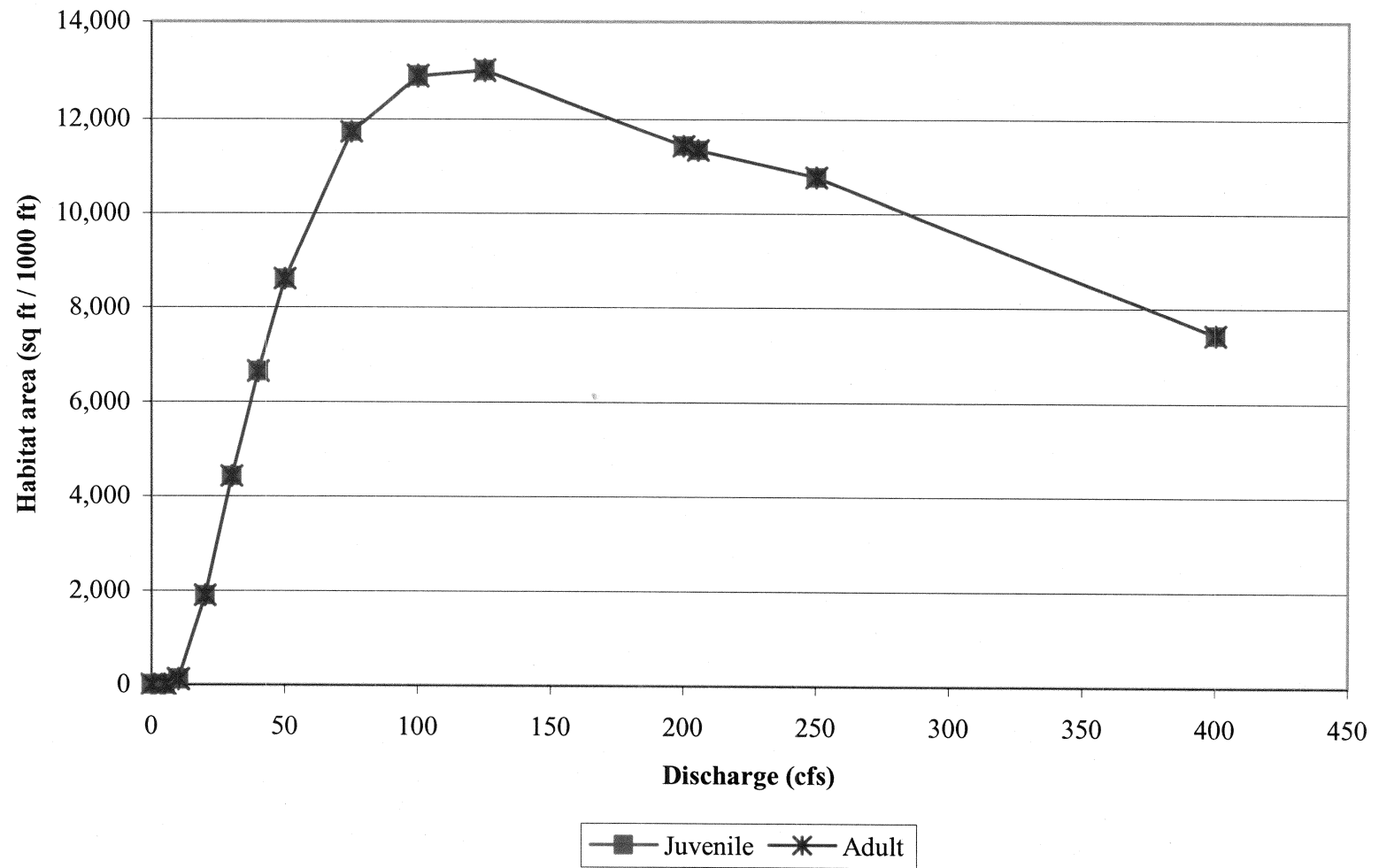
Longnose Dace Habitat versus Discharge, S. Platte Downstream



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Preliminary Results— Subject to
Revision

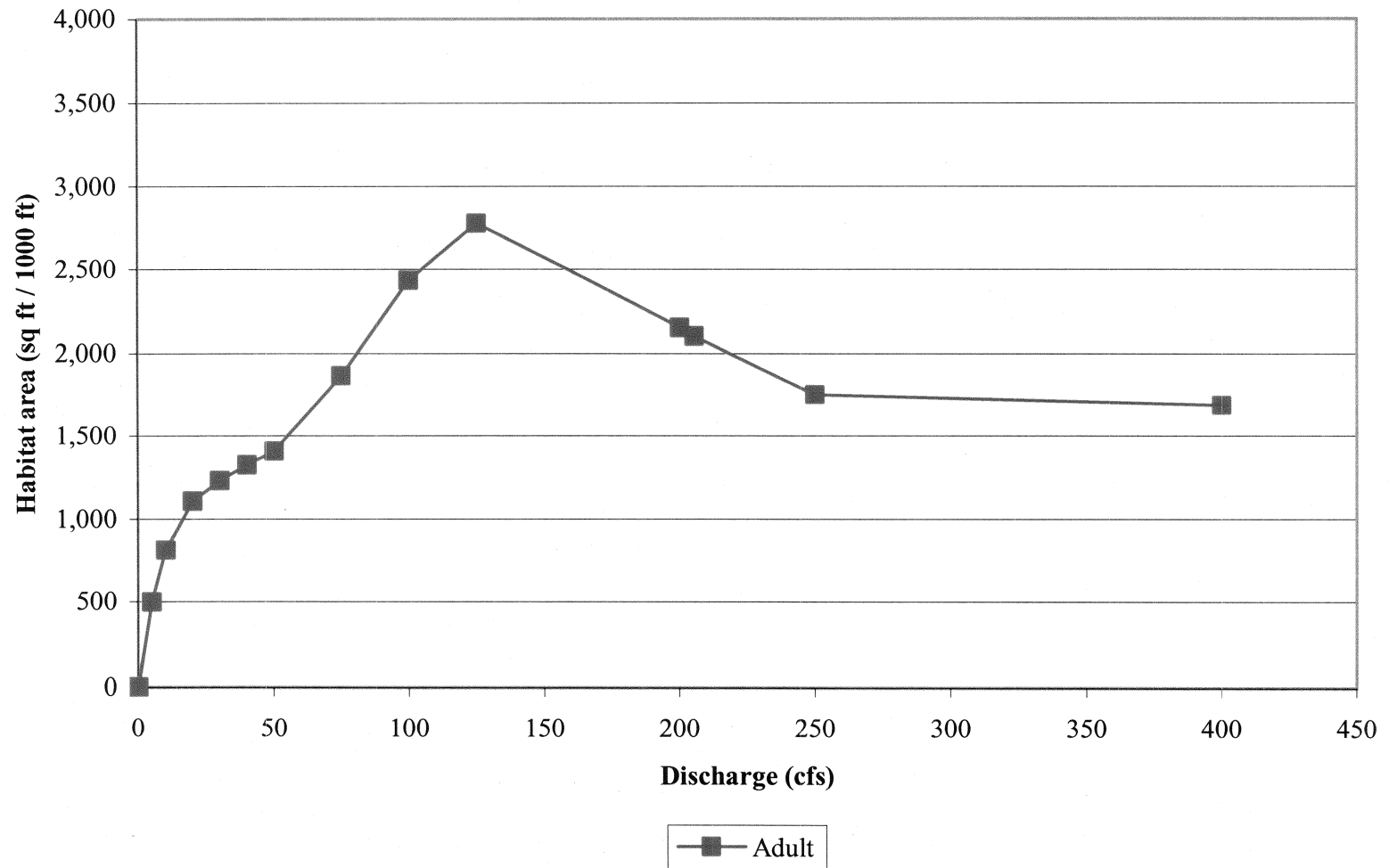
White Sucker Habitat versus Discharge, S. Platte Downstream



November 17, 2006

Preliminary Results— Subject to
Revision

Common Carp Habitat versus Discharge, S. Platte Downstream



November 17, 2006

Preliminary Results – Subject to
Revision